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(12) **United States Patent**
Haegel et al.(10) **Patent No.:** **US 9,221,912 B2**
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- (54) **ANTIBODY AGAINST THE CSF-1R**
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- (73) Assignee: **Transgene S.A.**, Illkirch Graffenstaden (FR)
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- This patent is subject to a terminal disclaimer.
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- (22) Filed: **Jul. 1, 2013**
- (65) **Prior Publication Data**
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Related U.S. Application Data

- (62) Division of application No. 12/922,441, filed as application No. PCT/EP2009/001733 on Mar. 11, 2009, now Pat. No. 8,604,170.
- (60) Provisional application No. 61/043,884, filed on Apr. 10, 2008.

Foreign Application Priority Data

Mar. 14, 2008 (EP) 08360005

- (51) **Int. Cl.**
C07H 21/04 (2006.01)
C07K 16/28 (2006.01)
A61K 39/00 (2006.01)
- (52) **U.S. Cl.**
CPC **C07K 16/2866** (2013.01); **A61K 2039/505** (2013.01); **C07K 2317/24** (2013.01); **C07K 2317/56** (2013.01); **C07K 2317/565** (2013.01)
- (58) **Field of Classification Search**
None
See application file for complete search history.

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(57) **ABSTRACT**

The present invention provides antibodies specific for the CSF-1R, compositions comprising said antibodies and methods of treatment using such compositions.

19 Claims, 18 Drawing Sheets

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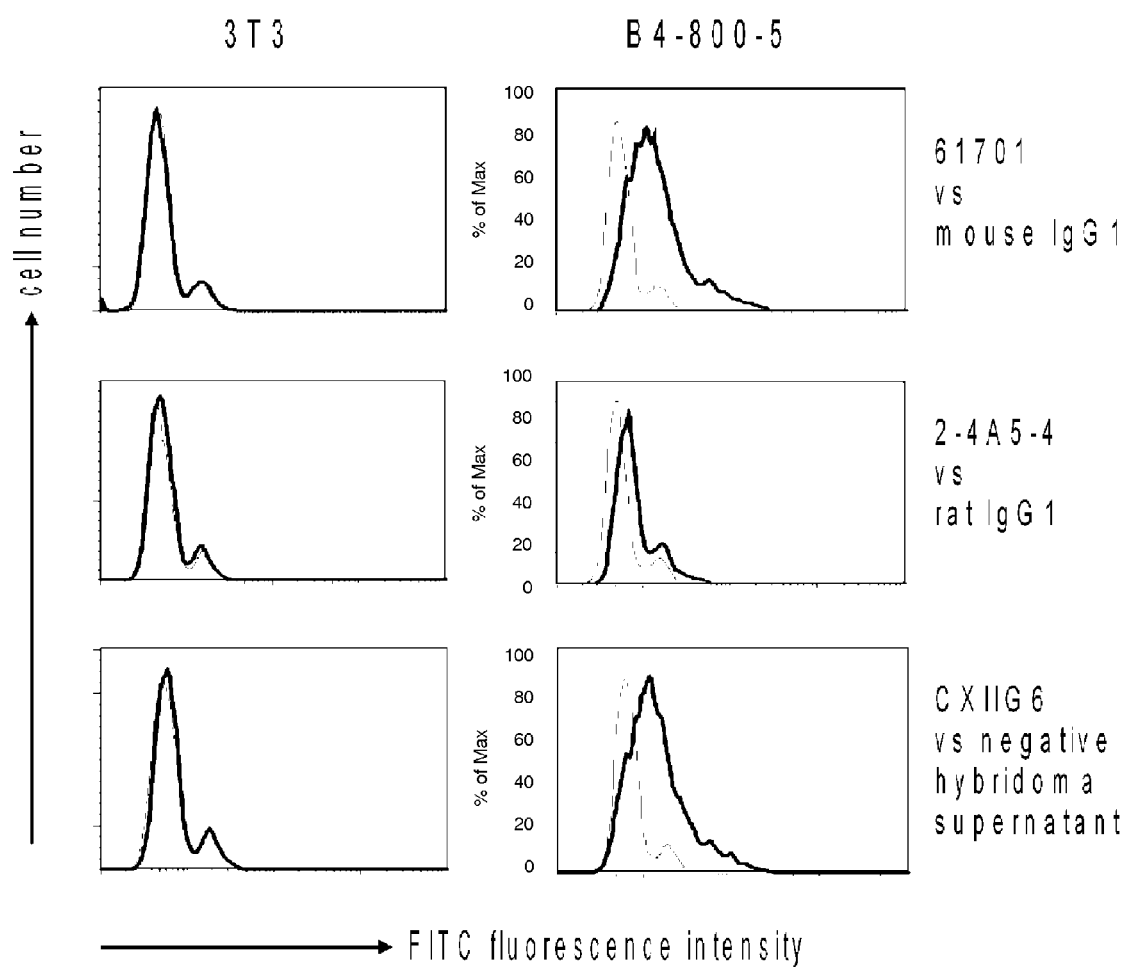


Fig. 1

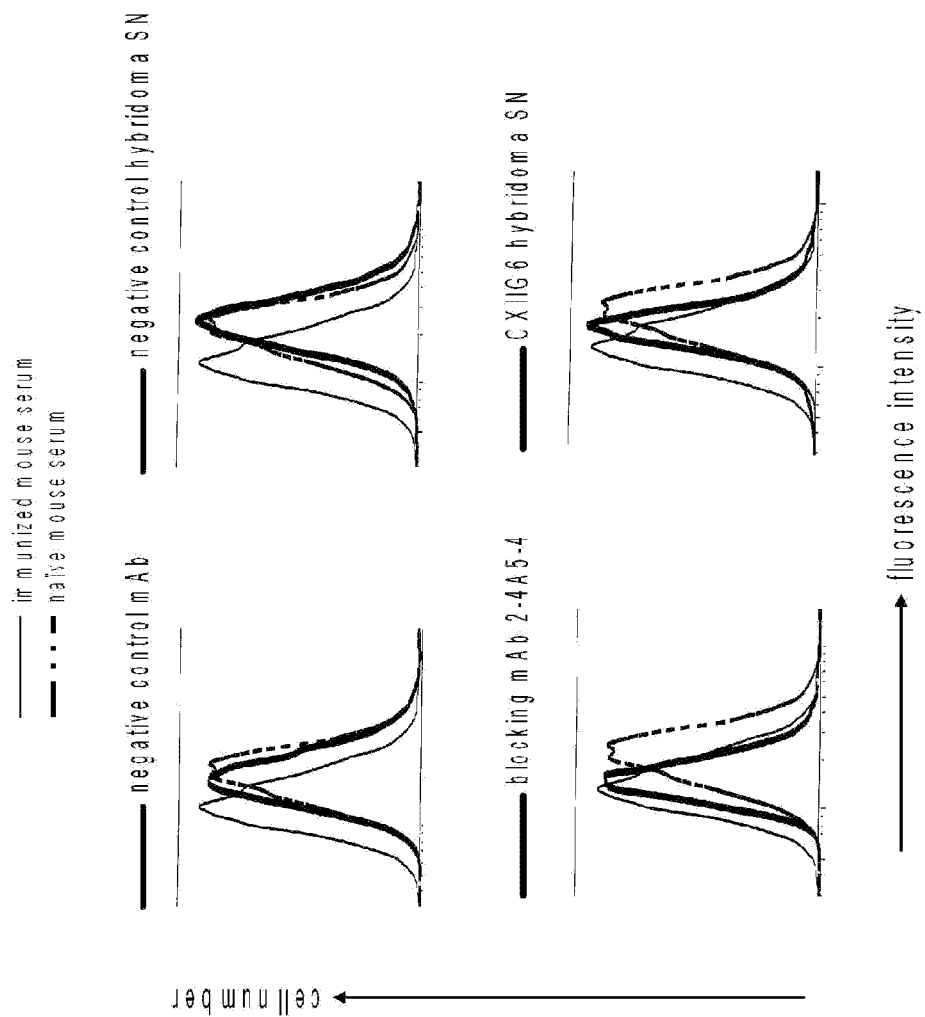


Fig. 2

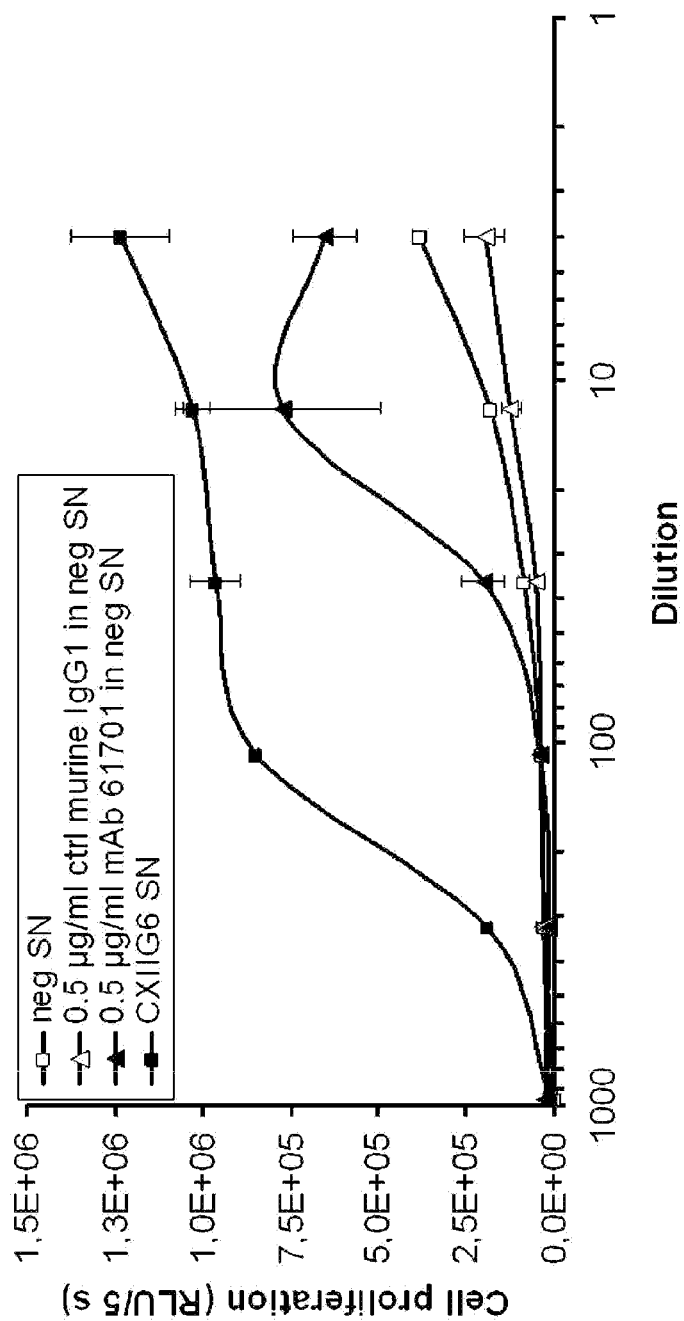


Fig. 3

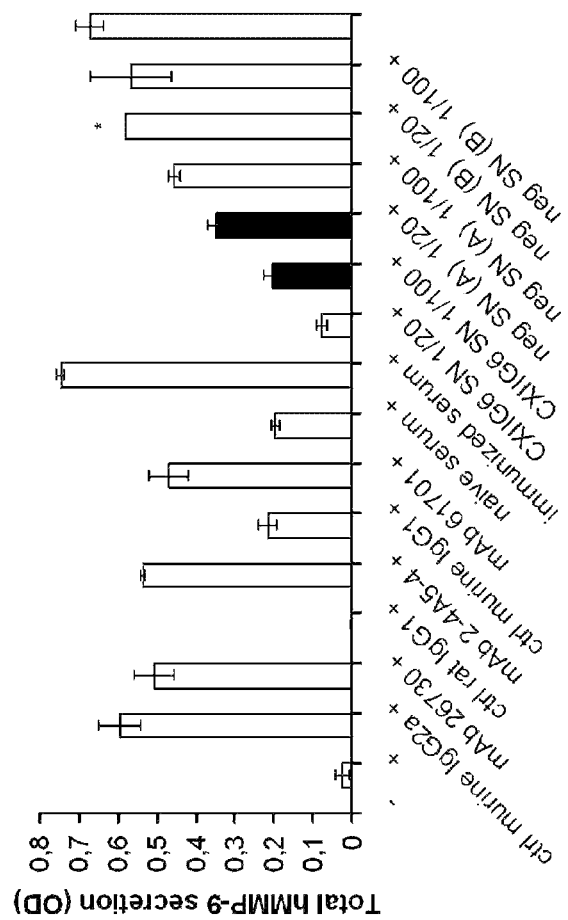


Fig. 4



Fig. 5

SfiI
GGCCCAGCCGGCCAGTGACAGACACAGACATAGAACATTACGATGTACTTGGGACTGA 60
M Y L G L N
ACTATGTATTTCATAGTTTTTCTCCTAAATGGTGTCCAGAGTGAAGTGAAGCTTGAGGAGT 120
Y V F I V F L L N G V Q S E V K L E E S
CTGGAGGAGGCTTGGTGCAGCCTGGAGGATCCATGAACTCTCTTGTGCTGCCTCTGGAT 180
G G G L V Q P G G S M K L S C A A S G F
TCACTTTTAGTGACGCCTGGATGGACTGGGTCCGCCAGTCTCCAGAGATGGGACTTGAGT 240
T F S D A W M D W V R Q S P E M G L E W
GGGTTGCTGAAATTAGAAGCAAAGCTAATAATCATGCAACATTCTATGCTGAGTCTGTGA 300
V A E I R S K A N N H A T F Y A E S V K
AAGGGAGGTTACCATCTCAAGAGATGATTCCAAAAGTAGTGTCTACCTGCAAATGAACA 360
G R F T I S R D D S K S S V Y L Q M N S
GCTTAAGACCTGAAGACACTGGCATTATTACTGTACCAGGGTAAAGGTAGGCTTTGACA 420
L R P E D T G I Y Y C T R V K V G F D N
ACTGGGGCCAAGGCACCACTCTCACAGTCTCCTCAGCCAAAACAACAGCCCCATCGGTCT 480
W G Q G T T L T V S S A K T T A P S V Y
ATCCACTGGCCCCCTGTGTGTGGAGATACAACCTCGGTCTCGGTGACTCTAGGATGCCTGG 540
P L A P V C G D T T G S S V T L G C L V
TCAAGGGTTATTTCCCTGAGCCAGTGACCTTGACCTGGAACCTCTGGATCCCTGTCCAGTG 600
K G Y F P E P V T L T W N S G S L S S G
GTGTGCACACCTTCCCAGCTGTCTGCAGTCTGACCTCTACACCCTCAGCAGCTCAGTGA 660
V H T F P A V L Q S D L Y T L S S S V T

XhoI
CTGTAACCTCGAGCACCTGGCCCAGCCAGTCCATCACCTGCAATGTGGCCCACCCGGCAA 720
V T S S T W P S Q S I T C N V A H P A S
GCAGACCAAGGTGGACAAGAAAATTGAGCCCAGAGGGCCACAATCAAGCCCTGTCTCTC 780
S T K V D K K I E P R G P T I K P C P P
CATGCAAATGCCCAGCACCTAACCTCTTGGGTGGACCATCCGTCTTCATCTTCCCTCCAA 840
C K C P A P N L L G G P S V F I F P P K
AGATCAAGGATGTACTCATGATCTCCCTGAGCCCCATAGTCACATGTGTGGTGGTGGATG 900
I K D V L M I S L S P I V T C V V V D V
TGAGCGAGGATGACCCAGATGTCCAGATCAGCTGGTTTGTGAACAACGTGGAAGTACACA 960
S E D D P D V Q I S W F V N N V E V H T
CAGCTCAGACACAAACCCATAGAGAGGATTACAACAGTACTCTCCGGGTGGTCAGTGCCC 1020
A Q T Q T H R E D Y N S T L R V V S A L
TCCCCCTCAGCACCAAGGACTGGATGAGTGGCAAGGAGTTCAAATGCAAGGTCAACAACA 1080
P I Q H Q D W M S G K E F K C K V N N K
AAGACCTCCCAGCGCCCATCGAGAGAACCATCTCAAAACCCAAAGGGTCAGTAAGAGCTC 1140
D L P A P I E R T I S K P K G S V R A P
CACAGGTATATGTCTTGCCTCCACCAGAAGAAGAGATGACTAAGAAACAGGTCACTCTGA 1200
Q V Y V L P P P E E E M T K K Q V T L T
CCTGCATGGTCACAGACTTCATGCCTGAAGACATTTACGTGGAGTGGACCAACAACGGGA 1260
C M V T D F M P E D I Y V E W T N N G K
AAACAGAGCTAAACTACAAGAACACTGAACCAGTCCTGGACTCTGATGGTTCTTACTTCA 1320
T E L N Y K N T E P V L D S D G S Y F M
TGTACAGCAAGCTGAGAGTGGAAAAGAAGAACTGGGTGGAAAGAAATAGCTACTCTGT 1380
Y S K L R V E K K N W V E R N S Y S C S
CAGTGGTCCACGAGGGTCTGCACAATCACCACACGACTAAGAGCTTCTCCCGGACTCCGG 1440
V V H E G L H N H H T T K S F S R T P G

NotI
GTAAATGAGCTCAGCACCCACAAAACCTCTCAGGTCCAAAGAGACACCCACGCGGCCGC 1498
K *

Fig. 6

SfiI
GGCCCAGCCGGCCGGAGTCAGCCTCACACTGATCACACACAGACATGAGTGTGCCCACTC 60
M S V P T Q

AGGTCCTGGGGTTGCTGCTGCTGTGGCTTACAGATGCCAGATGTGACATCCAGATGACTC 120
V L G L L L L W L T D A R C D I Q M T Q

AGTCTCCAGCCTCCCTATCTGTATCTGTGGGAGAACTGTCACCATCACATGTCGAGCAA 180
S P A S L S V S V G E T V T I T C R A S

GTGAGAATATTTACAGTAATTTAGCATGGTATCAGCAGAAACAGGGAAAAATCTCCTCAGC 240
E N I Y S N L A W Y Q Q K Q G K S P Q L

TCCTGGTCCATGCTGCAACAACTTAGCAGATGGTGTGCCATCAAGGTTCACTGGGCAGTG 300
L V H A A T N L A D G V P S R F S G S G

GATCAGGCACACAGTATTCCTCAAGATCAACAGCCTGCAGTCTGAAGATTTTGGGAGTT 360
S G T Q Y S L K I N S L Q S E D F G S Y

ATTACTGTCAACATTTTTTGGGGTACTCCTCGGACGTTTCGGTGGAGGCACCAAGTTGGAAA 420
Y C Q H F W G T P R T F G G G T K L E I

TCAAACGGGCTGATGCTGCACCAACTGTATCCATCTTCCCACCATCCAGTGAGCAGTTAA 480
K R A D A A P T V S I F P P S S E Q L T

CATCTGGAGGTGCCTCAGTCGTGTGCTTCTTGAACAACTTCTACCCCAAAGACATCAATG 540
S G G A S V V C F L N N F Y P K D I N V

TCAAGTGGAAGATTGATGGCAGTGAACGACAAAATGGCGTCCTGAACAGTTGGACTGATC 600
K W K I D G S E R Q N G V L N S W T D Q

AGGACAGCAAAGACAGCACCTACAGCATGAGCAGCACCCCTCACGTTGACCAAGGACGAGT 660
D S K D S T Y S M S S T L T L T K D E Y

ATGAACGACATAACAGCTATACCTGTGAGGCCACTCACAAGACATCAACTTCACCCATTG 720
E R H N S Y T C E A T H K T S T S P I V

TCAAGAGCTTCAACAGGAATGAGTGTTAGAGACAAAGGTCCTGAGACGCCACCACCAGCT 788
K S F N R N E C *

NotI
GCGGCCGC 788

Fig. 7

pTG17753

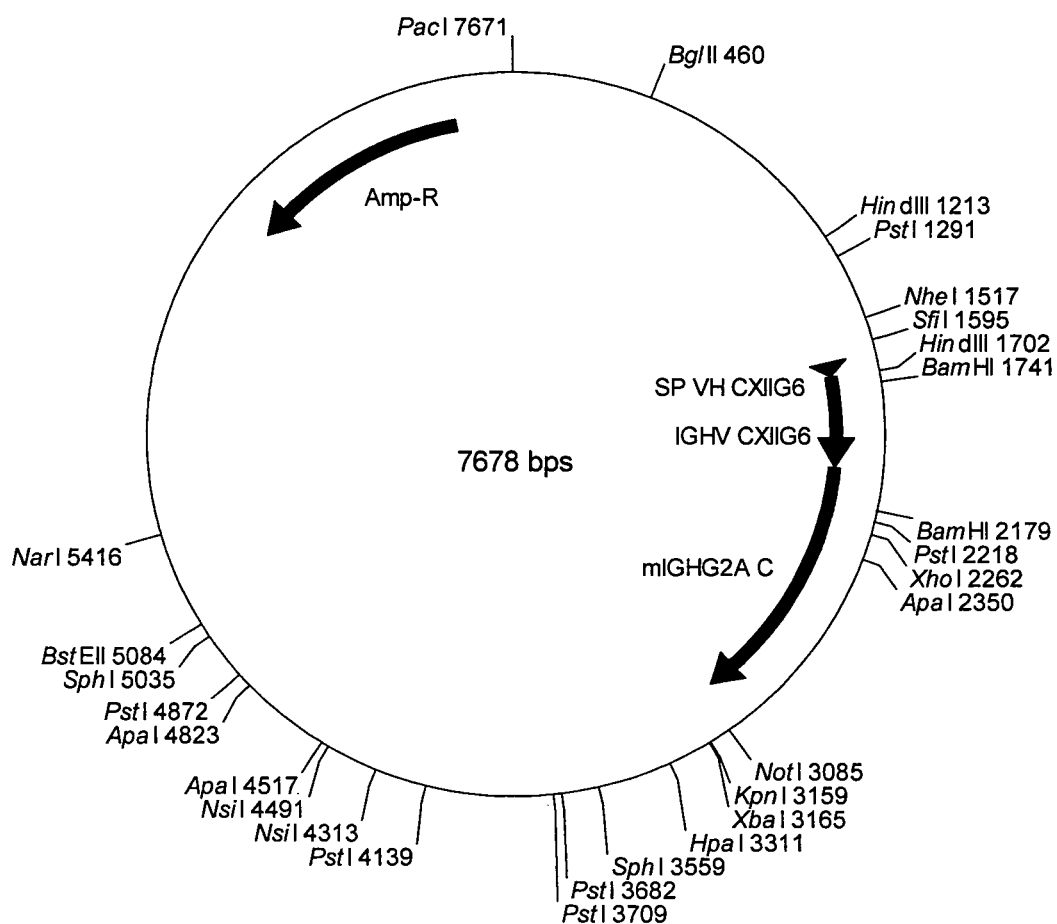


Fig. 8

pTG17727

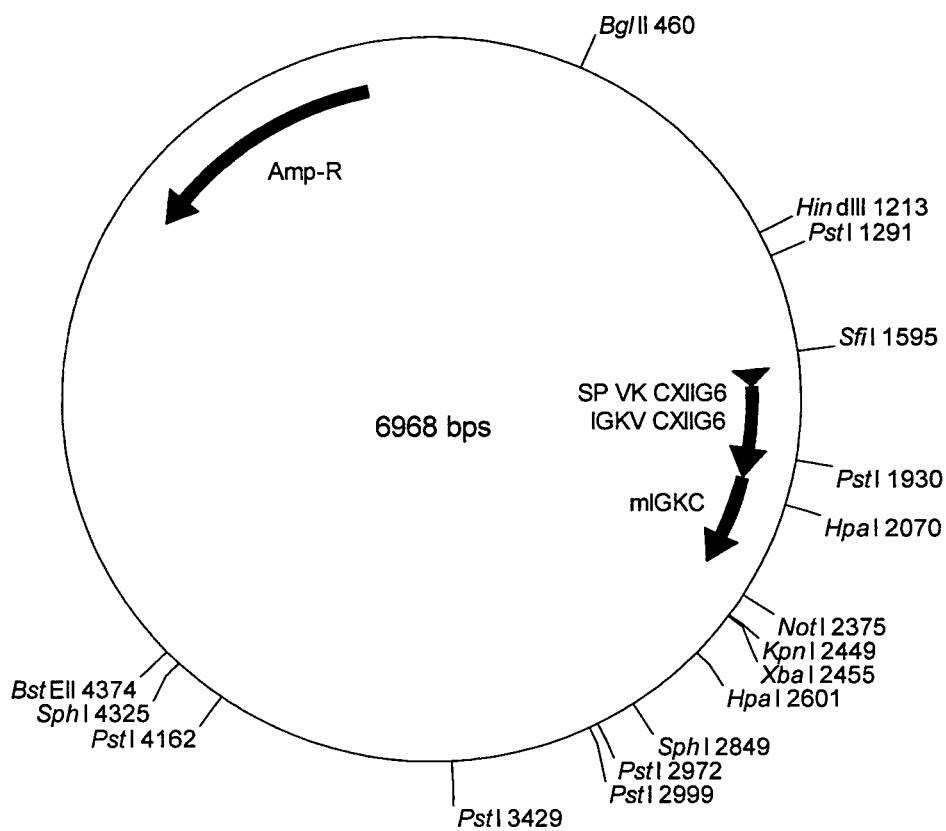


Fig. 9

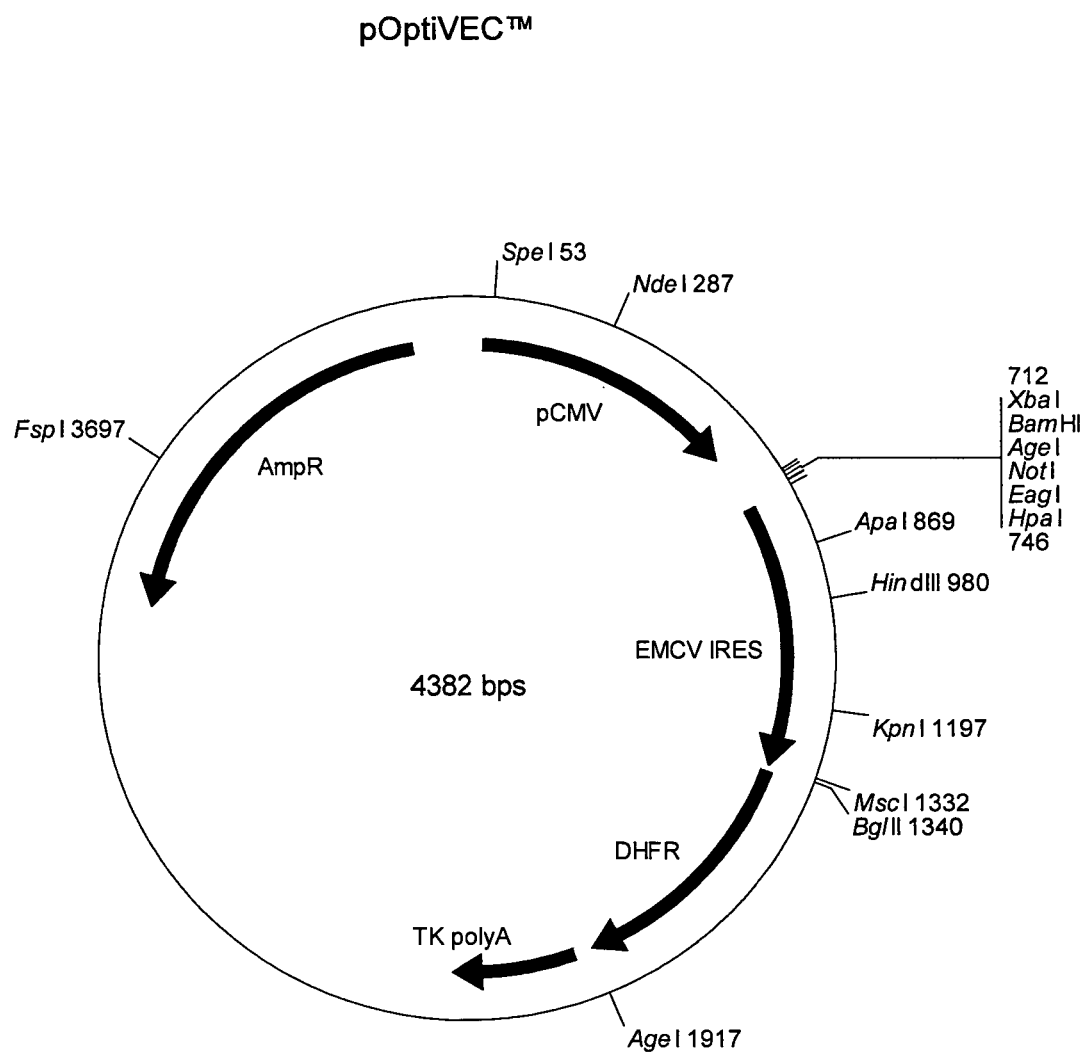


Fig. 10

pTG17895

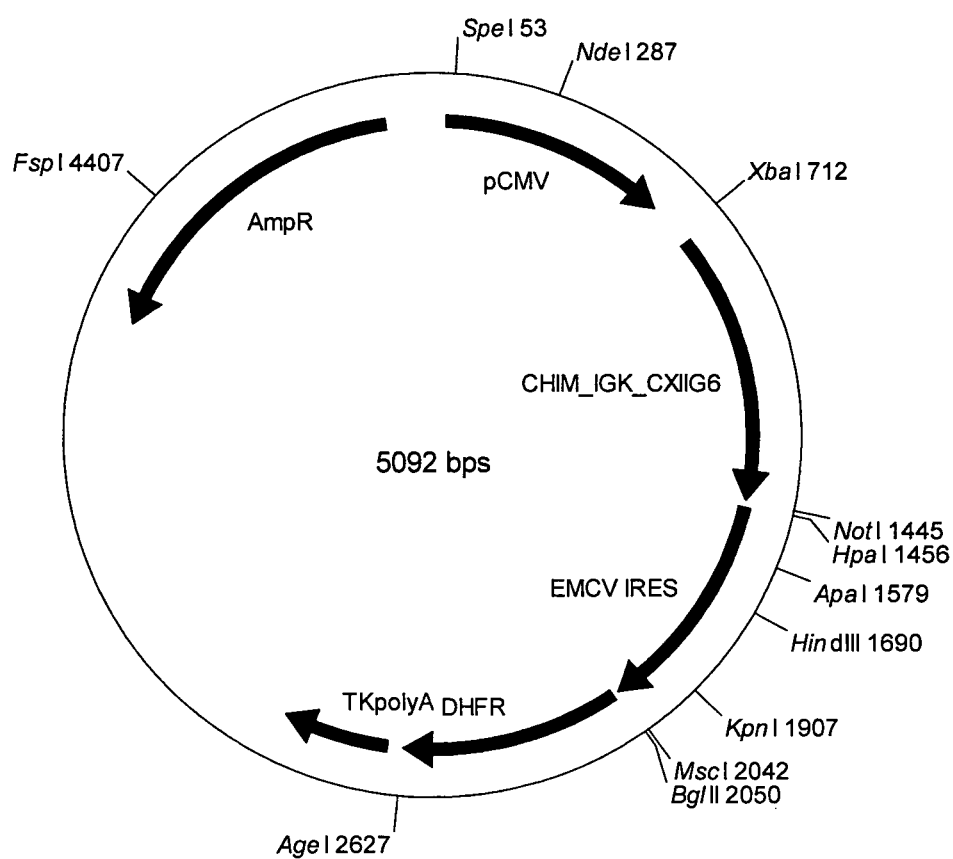


Fig. 11

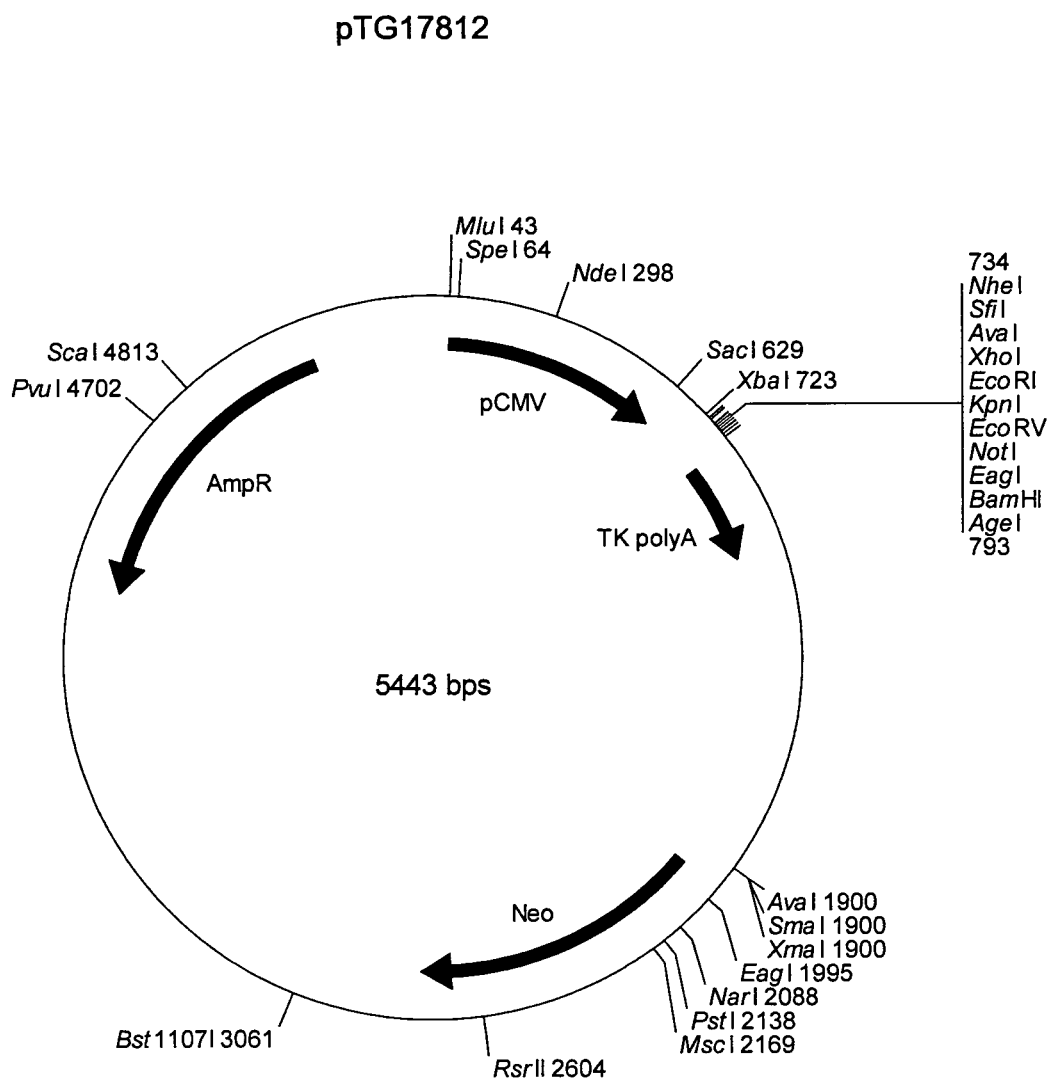


Fig. 12

pTG17868

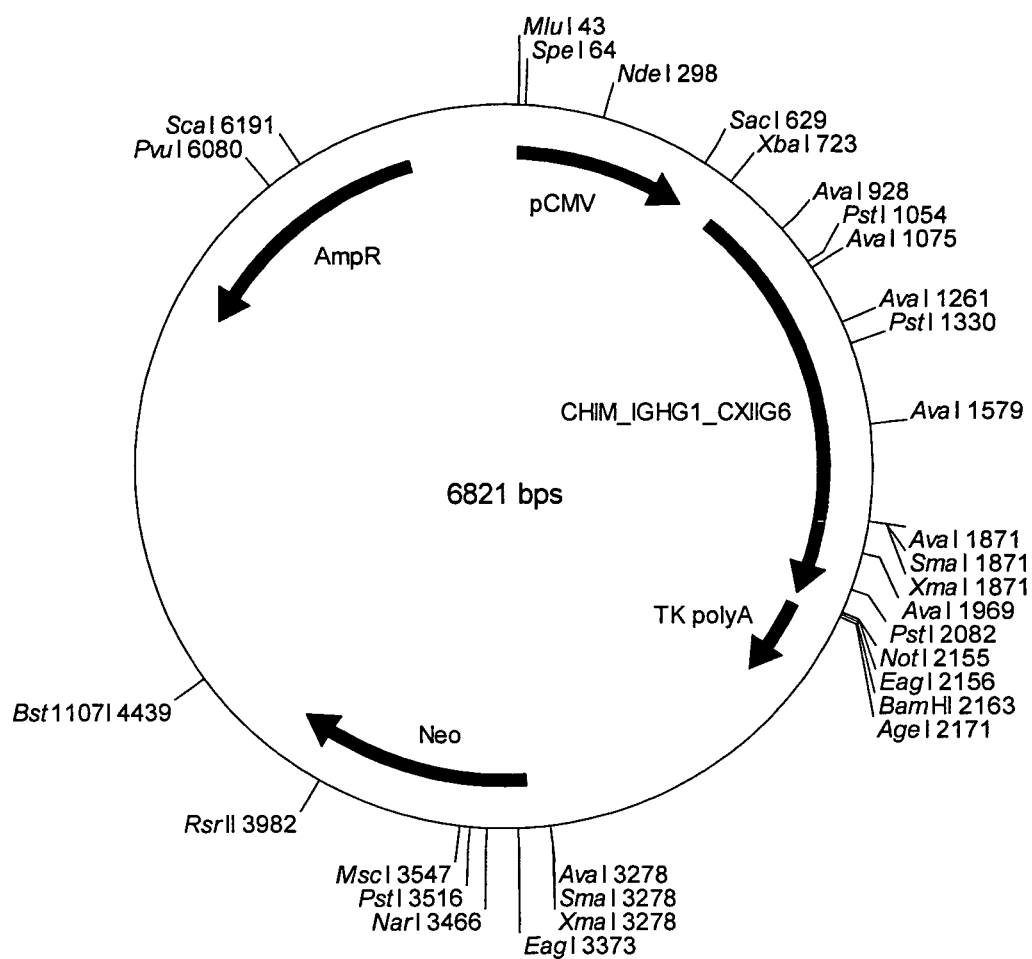


Fig. 13

pTG17869

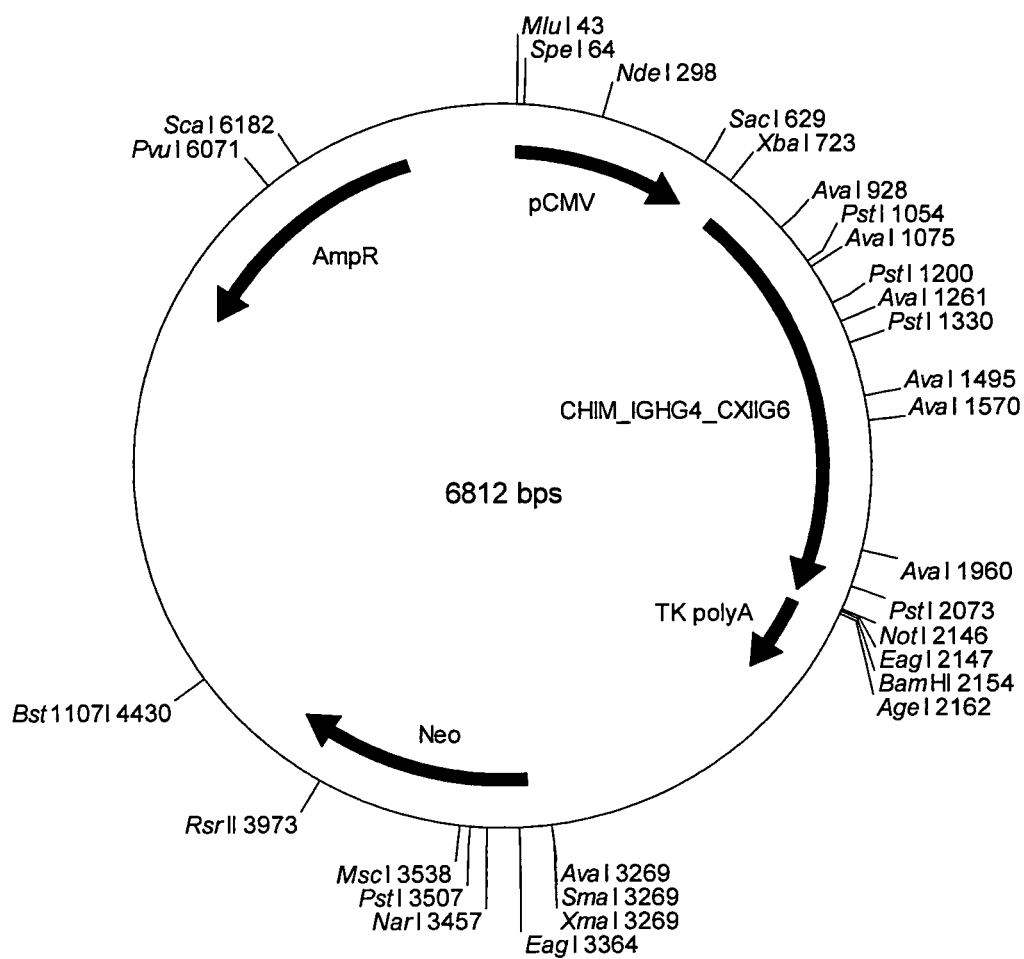


Fig. 14

		Substituted amino acids ^a in VL CXIIIG																			
K1	PTG17896	A9S	V13A	E17D	T18R	Q40P	S43A	Q45K	V46L	H49Y	N53R	A55E	D56S	Q70D	S72I	K74T	N76S	S80P	G84A	S85T	G109Q
K2	PTG17897	A9S	V13A	E17D	T18R		S43A	Q45K	V46L	H49Y	N53R	A55E	D56S	Q70D	S72I	K74T	N76S		G84A	S85T	G109Q
K3	PTG17899	A9S	V13A	E17D	T18R		S43A	Q45K	V46L			A55E	D56S	Q70D	S72I	K74T	N76S		G84A	S85T	G109Q
K4	PTG17900	A9S		E17D	T18R		S43A	Q45K		H49Y	N53R	A55E	D56S	Q70D	S72I	K74T	N76S			S85T	G109Q
K5	PTG17901	A9S		E17D	T18R	Q40P	S43A	Q45K				A55E	D56S	Q70D	S72I	K74T	N76S	S80P		S85T	G109Q
K6	PTG17902	A9S		E17D	T18R		S43A	Q45K				A55E	D56S	Q70D	S72I	K74T	N76S			S85T	G109Q
K7	PTG17903	A9S		E17D	T18R		S43A	Q45K					D56S	Q70D			N76S				G109Q
K8	PTG17904			E17D																	G109Q
K9	PTG17905	A9S	V13A	E17D	T18R		S43A	Q45K	V46L				D56S	Q70D	S72I	K74T	N76S		G84A	S85T	G109Q
K10	PTG17906	A9S		E17D	T18R	Q40P	S43A	Q45K					D56S	Q70D	S72I	K74T	N76S	S80P		S85T	G109Q
K11	PTG17907	A9S		E17D	T18R		S43A	Q45K					D56S	Q70D	S72I	K74T	N76S			S85T	G109Q
K12	PTG17947	A9S	V13A	E17D	T18R	Q40D	S43A	Q45K					D56S	Q70D	S72I	K74T	N76S	S80P			G109Q
K13	PTG17948	A9S	V13A	E17D	T18R	Q40D	S43A	Q45K	V46L				D56S	Q70D	S72I	K74T	N76S	S80P	G84A	S85T	G109Q
K14	PTG17949	A9S	V13A	E17D	T18R	Q40P	S43A	Q45K					D56S	Q70D	S72I	K74T	N76S	S80P			G109Q
K15	PTG17950	A9S	V13A	E17D	T18R	Q40P	S43A	Q45K	V46L				D56S	Q70D	S72I	K74T	N76S	S80P	G84A	S85T	G109Q

^aamino acids in bold have a relative side-chain solvent-accessibility above 50 %, underlined above 25%

Fig. 15

Substituted amino acids ^a in V _H CXIR36																				
H1	PTG17870	K3Q	E5V	M18L	K19R	S40A	E42G	M43K	A49G	E50R	F61E	E64A	S79N	V81L	R89K	P90I	G94A	T95V	T113L	L114V
H2	PTG17871	K3Q	E5V	M18L	K19R	S40A	E42G	M43K	A49G	E50R	F61E	E64A	S79N	V81L	R89K	P90I	G94A	T95V	T113L	
H3	PTG17872	K3Q	E5V	M18L	K19R	S40A	E42G	M43K	A49G	E50R	F61E	E64A	S79N	V81L	R89K	P90I	G94A	T95V		L114V
H4	PTG17873	K3Q	E5V	M18L	K19R	S40A	E42G	M43K	A49G	E50R		E64A	S79N	V81L	R89K		G94A	T95V	T113L	L114V
H5	PTG17874	K3Q	E5V	M18L	K19R	S40A	E42G	M43K	A49G	E50R		E64A	S79N	V81L	R89K		G94A	T95V	T113L	
H6	PTG17875	K3Q	E5V	M18L	K19R	S40A	E42G	M43K	A49G	E50R		E64A	S79N	V81L	R89K		G94A	T95V		L114V
H7	PTG17883	K3Q	E5V		K19R	S40A	E42G	M43K				E64A	S79N		R89K			T95V	T113L	L114V
H8	PTG17884	K3Q	E5V		K19R	S40A	E42G	M43K				E64A	S79N		R89K			T95V	T113L	
H9	PTG17885	K3Q	E5V		K19R	S40A	E42G	M43K				E64A	S79N		R89K			T95V		L114V
H10	PTG17886	K3Q	E5V		K19R		E42G	M43K				E64A			R89K				T113L	L114V
H11	PTG17887	K3Q	E5V		K19R		E42G	M43K				E64A			R89K				T113L	
H12	PTG17888	K3Q	E5V		K19R		E42G	M43K				E64A			R89K				T113L	L114V
H13	PTG17889				K19R										R89K				T113L	
H14	PTG17890				K19R										R89K				T113L	L114V
H15	PTG17891				K19R										R89K					L114V
H16	PTG17892	K3Q	E5V	M18L	K19R	S40A	E42G	M43K	A49G			E64A	S79N	V81L	R89K		G94A	T95V	T113L	L114V
H17	PTG17893	K3Q	E5V	M18L	K19R	S40A	E42G	M43K	A49G			E64A	S79N	V81L	R89K		G94A	T95V	T113L	
H18	PTG17894	K3Q	E5V	M18L	K19R	S40A	E42G	M43K	A49G			E64A	S79N	V81L	R89K		G94A	T95V		L114V
H19	PTG17943	K3Q	E5V	M18L												P90A				
H20	PTG17944	K3Q	E5V	M18L	K19R		E42G	M43K				E64A			R89K				T113L	L114V
H21	PTG17945	K3Q	E5V	M18L	K19R		E42G	M43K				E64A			R89K	P90A			T113L	L114V
H22	PTG17946	K3Q	E5V	M18L	K19R	S40A	E42G	M43K				E64A			R89K	P90A		T95V	T113L	L114V
H23	PTG17968	K3Q	E5V	M18L	K19R		E42G	M43K							R89K				T113L	L114V
H24	PTG17969	K3Q	E5V	M18L	K19R		E42G	M43K							R89K	P90A			T113L	L114V
H25	PTG17970	K3Q	E5V	M18L	K19R	S40A	E42G	M43K							R89K	P90A		T95V	T113L	L114V
H26	PTG17985	K3Q	E5V	M18L	K19R		E42G	M43K							R89K	P90I			T113L	L114V
H27	PTG17986	K3Q	E5V	M18L	K19R	S40A	E42G	M43K							R89K	P90I		T95V	T113L	L114V

^aamino acids in bold have a relative side-chain solvent-accessibility above 50 %, underlined above 25 %.

Fig. 16

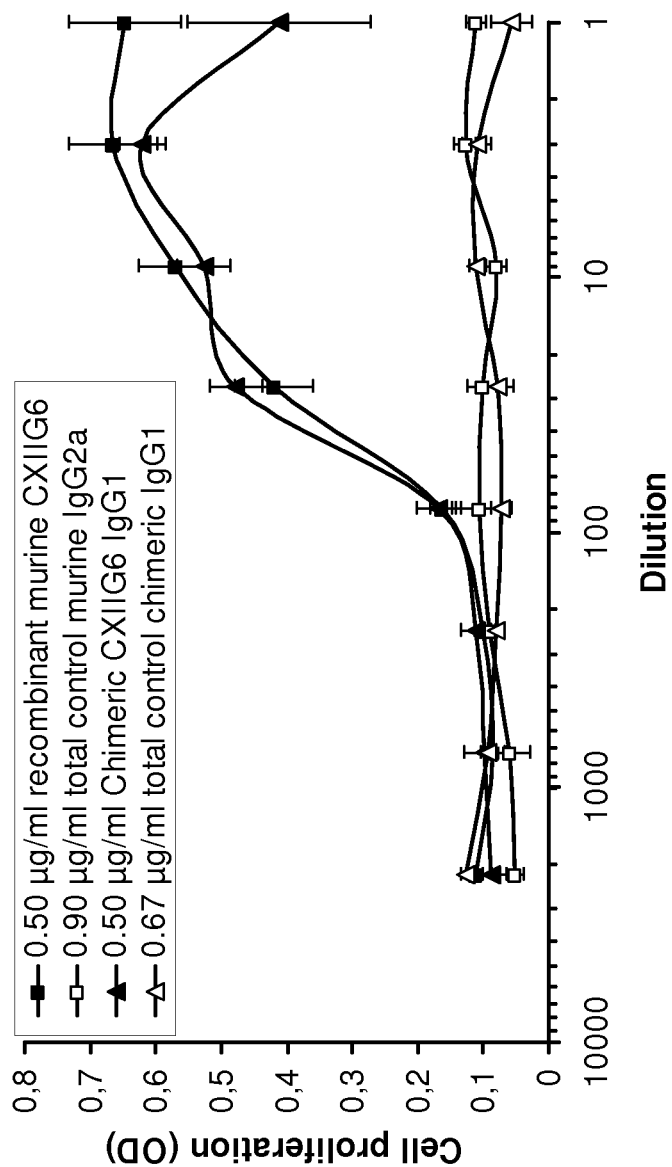


Fig. 17

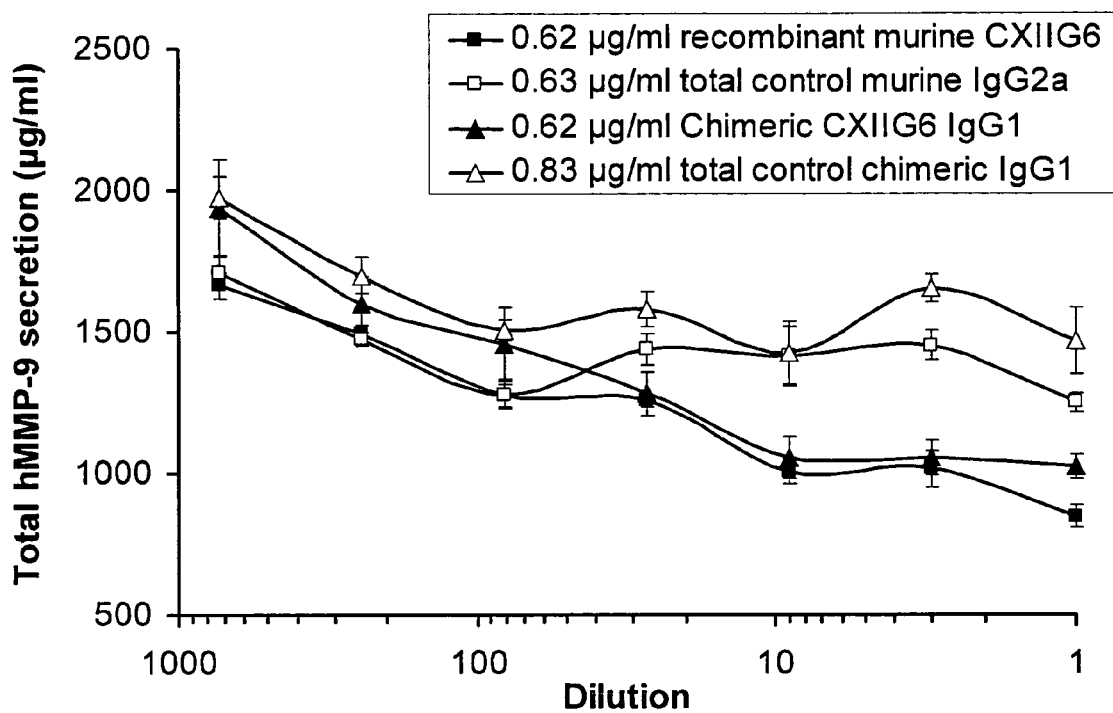


Fig. 18

ANTIBODY AGAINST THE CSF-1R

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a division of U.S. application Ser. No. 12/922,441, with 35 U.S.C. §371(c) date Dec. 7, 2010, now U.S. Pat. No. 8,604,170, which is a U.S. national phase application based on PCT/EP2009/001733, filed Mar. 11, 2009, which claims priority to European Application No. 08 36 0005.6, filed Mar. 14, 2008, and to U.S. Provisional Application No. 61/043,884, filed Apr. 10, 2008, all of which are incorporated by reference herein.

The CSF-1 (Colony-Stimulating Factor-1) is a cytokine expressed particularly by various types of cells. It is a differentiation, growth and survival factor for cells of the mononuclear phagocyte lineage which express the receptor for CSF-1 (CSF-1R) (SHERR. Colony-stimulating factor-1 receptor. *blood*. 1990, vol. 75, no. 1, p. 1-12.). CSF-1R is a tyrosine kinase receptor encoded by the *c-fms* protoonogene containing an intracellular kinase domain and a ligand-binding extracellular region organized in five immunoglobulin-like subdomains. Response to CSF-1 results in increased survival, growth, differentiation, and reversible changes in function. The *c-fms* gene is itself a macrophage differentiation marker. The extent of *c-fms* expression is stronger than that of other macrophage-specific genes including lysozyme and a macrophage-specific protein tyrosine phosphatase. (HUME, et al. Regulation of CSF-1 receptor expression. *Molecular reproduction and development*. 1997, vol. 46, no. 1, p. 46-52.).

In addition to cells of the mononuclear phagocyte lineage, the CSF-1R is also expressed by many types of human tumors. In breast cancer, CSF-1R expression is associated with larger tumor sizes and decreased survival (KLUGER, et al. Macrophage colony-stimulating factor-1 receptor expression is associated with poor outcome in breast cancer by large cohort tissue microarray analysis. *Clinical cancer research*. 2004, vol. 10, no. 1, p. 173-7.; SCHOLL, et al. Anti-colony-stimulating factor-1 antibody staining in primary breast adenocarcinomas correlates with marked inflammatory cell infiltrates and prognosis. *Journal of the National Cancer Institute*. 1994, vol. 86, no. 2, p. 120-6.). In epithelial ovarian cancer, the majority of primary tumors and metastases strongly express the CSF-1R, and metastases frequently co-express CSF-1 and CSF-1R. The CSF-1R is also expressed by tumor-infiltrating macrophages (CHAMBERS, et al. Over-expression of epithelial macrophage colony-stimulating factor (CSF-1) and CSF-1 receptor: a poor prognostic factor in epithelial ovarian cancer, contrasted with a protective effect of stromal CSF-1. *Clinical Cancer Research*. 1997, vol. 3, no. 6, p. 999-1007.). In ovarian and endometrial cancers, Northern blot analysis shows that the vast majority of tumors co-express CSF-1 and CSF-1R, while CSF-1R expression is only weakly detected in normal endometrial tissue samples (BAÏOCCHI, et al. Expression of the macrophage colony-stimulating factor and its receptor in gynecologic malignancies. *Cancer*. 1991, vol. 67, no. 4, p. 990-6.). In cervical carcinomas, CSF-1R expression is up-regulated both in tumor stroma and in tumor epithelium, compared with normal endometrium (KIRMA, et al. Elevated expression of the oncogene *c-fms* and its ligand, the macrophage colony-stimulating factor-1, in cervical cancer and the role of transforming growth factor-beta1 in inducing *c-fms* expression. *Cancer res*. 2007, vol. 67, no. 5, p. 1918-26.). In renal carcinoma, infiltration of tumor-associated macrophages expressing high levels of CSF-1R is associated with tumor progression

(HEMMERLEIN, et al. Expression of acute and late-stage inflammatory antigens, *c-fms*, CSF-1, and human monocytic serine esterase 1, in tumor-associated macrophages of renal cell carcinomas. *Cancer immunology, immunotherapy* 2000, vol. 49, no. 9, p. 485-92.). CSF-1R is expressed by close to 100% prostatic intraepithelial neoplasia or cancer samples (IDE, et al. Expression of colony-stimulating factor 1 receptor during prostate development and prostate cancer progression. *Proc. Natl. Acad. Sci U.S.A.* 2002, vol. 99, no. 22, p. 14404-9.). CSF-1R expression has also been detected in acute myeloblastic leukemias and B-cell chronic lymphocytic leukemias (RAMBALDI, et al. Expression of the macrophage colony-stimulating factor and *c-fms* genes in human acute myeloblastic leukemia cells. *Journal of Clinical Investigation*. 1988, vol. 81, no. 4, p. 1030-5.).

Work done by immunohistochemistry and in situ hybridization has demonstrated specificity of the expression of CSF-1 in invasive breast cancer cells while such production is not observed in intra-canal or non-invasive tumor cells (SCHOLL, et al. Anti-colony-stimulating factor-1 antibody staining in primary breast adenocarcinomas correlates with marked inflammatory cell infiltrates and prognosis. *Journal of the National Cancer Institute*. 1994, vol. 86, no. 2, p. 120-6.; TANG, et al. M-CSF (monocyte colony stimulating factor) and M-CSF receptor expression by breast tumour cells: M-CSF mediated recruitment of tumour infiltrating monocytes?. *Journal of cellular biochemistry*. 1992, vol. 50, no. 4, p. 350-6.). Production of CSF-1 by invasive tumor cells correlates with its increase in concentration in the plasma of patients, where it can exceed 1000 pg/ml compared with less than 300 pg/ml in normal subjects. High serum concentration correlates with advanced stages of the disease and unfavorable short term prognostic (SCHOLL, et al. Circulating levels of colony-stimulating factor 1 as a prognostic indicator in 82 patients with epithelial ovarian cancer. *British journal of cancer*. 1994, vol. 69, no. 2, p. 342-6.; SCHOLL. Circulating levels of the macrophage colony stimulating factor CSF-1 in primary and metastatic breast cancer patients. A pilot study. *Breast cancer research and treatment*. 1996, vol. 39, no. 3, p. 275-83.). Moreover, it has been demonstrated that CSF-1 stimulates mobility and invasiveness of tumor cells (DORSCH, et al. Macrophage colony-stimulating factor gene transfer into tumor cells induces macrophage infiltration but not tumor suppression. *European journal of immunology*. 1993, vol. 23, no. 1, p. 186-90.; WANG, et al. Induction of monocyte migration by recombinant macrophage colony-stimulating factor. *Journal of immunology*. 1988, vol. 141, no. 2, p. 575-9.; FILDERMAN, et al. Macrophage colony-stimulating factor (CSF-1) enhances invasiveness in CSF-1 receptor-positive carcinoma cell lines. *Cancer res*. 1992, vol. 52, no. 13, p. 3661-6.).

CSF-1 also has a chemotactic effect on precursors of the myeloid line, which facilitates infiltration of monocytes in the tumor. However, the presence of these monocytes is not sufficient to observe destruction of the tumor by the immune system. (DORSCH, et al. Macrophage colony-stimulating factor gene transfer into tumor cells induces macrophage infiltration but not tumor suppression. *European journal of immunology*. 1993, vol. 23, no. 1, p. 186-90.). It appears that at the high serum contents commonly found in patients suffering from tumors of the breast, ovaries or pancreas, CSF-1 orients the differentiation of these monocytes into macrophages and not into dendritic cells capable of presenting tumoral antigens and thus initiating an efficient cytotoxic immune response directed against tumor cells (SCHOLL. Circulating levels of the macrophage colony stimulating factor CSF-1 in primary and metastatic breast cancer patients. A pilot study.

Breast cancer research and treatment. 1996, vol. 39, no. 3, p. 275-83.; BARON, et al. Modulation of MHC class II transport and lysosome distribution by macrophage-colony stimulating factor in human dendritic cells derived from monocytes. *Journal of cell science*. 2001, vol. 114, no. pt5, p. 999-1010.).

CSF-1 is also essential for proliferation and differentiation of osteoclasts. (CECCHINI, et al. Role of CSF-1 in bone and bone marrow development. *Molecular reproduction and development*. 1997, vol. 46, no. 1, p. 75-83.). Osteoclasts are multinucleated cells that express the CSF-1R, deriving from hematopoietic precursors that are primarily responsible for the degradation of mineralized bone during bone development, homeostasis and repair. In various skeletal disorders such as osteoporosis, hypercalcemia of malignancy, rheumatoid arthritis, tumor metastases and Paget's disease, bone resorption by osteoclasts exceeds bone formation by osteoblasts leading to decreased bone mass, skeletal fragility and bone fracture. (BRUZZANITI, et al. Molecular regulation of osteoclast activity. *Reviews in endocrine*. 2006, vol. 7, no. 1-2, p. 123-39.). For example, patients with advanced breast cancer frequently develop metastasis to bone. Bone metastasis results in intractable pain and a high risk of fractures due to tumor-driven bone loss (osteolysis), which is caused by increased osteoclast activity (CICEK, et al. Breast cancer bone metastasis and current small therapeutics. *Cancer metastasis reviews*. 2006, vol. 25, no. 4, p. 635-44.). It has been shown that osteolysis is linked to a high level of circulating CSF-1 (KITAURA, et al. The journal of clinical investigation. *M-CSF mediates TNF-induced inflammatory osteolysis*. 2005, vol. 115, no. 12, p. 3418-27.).

The CSF-1 pathway is also involved in mediating intestinal inflammation in disease such as inflammatory bowel disease (MARSHALL, et al. Blockade of colony stimulating factor-1 (CSF-1) leads to inhibition of DSS-induced colitis. *Inflammatory bowel diseases*. 2007, vol. 13, no. 2, p. 219-24.), in mediating macrophage proliferation during acute allograft rejection (JOSE, et al. Blockade of macrophage colony-stimulating factor reduces macrophage proliferation and accumulation in renal allograft rejection. *American journal of transplantation*. 2003, vol. 3, no. 3, p. 294-300. and in HIV-1 replication in infected macrophage (KUTZA, et al. Macrophage colony-stimulating factor antagonists inhibit replication of HIV-1 in human macrophages. *Journal of immunology*. 2000, no. 164, p. 4955-4960.

For these reasons, the inhibition of the CSF-1 activity by various compounds has been proposed for the treatment of cancer and bone degradation.

BACKGROUND ART

WO 01/30381 relates to the use of inhibitors of the CSF-1 activity in the production of medicaments for the treatment of tumor diseases. The two proposed approaches for the inhibition of the CSF-1 activity are the suppression of the CSF-1 activity itself, and the suppression of the activity of the CSF-1R. Neutralizing antibodies against CSF-1 or its receptor are preferred as the inhibitors of CSF-1 activity.

WO 03/059395 describes combination products comprising a substance capable of inhibiting CSF-1 activity and a substance having a cytotoxic activity for the treatment of cancer.

WO 2005/068503 discloses a method for preventing and treating osteolysis, cancer metastasis and bone loss associated with cancer metastasis by administering an antibody against CSF-1 to a subject.

EP 1488792 A relates to the use of mono- and/or bicyclic aryl or heteroaryl quinazoline compounds which exhibit selective inhibition of differentiation, proliferation or mediator release by effectively inhibiting CSF-1R tyrosine kinase activity. This application also relates to the use of such compounds for the manufacture of a medicament for inhibiting abnormal cell proliferation.

US 2005059113 relates to antibodies and antigen-binding portions thereof that specifically bind to aCSF-1. The invention also relates to human anti-CSF-1 antibodies and antigen-binding portions thereof. This application invention also provides gene therapy methods using nucleic acid molecules encoding the heavy and/or light immunoglobulin molecules that comprise the human anti-CSF-1 antibodies.

DISCLOSURE OF INVENTION

The present invention relates to an antibody that specifically binds to the CSF-1R.

As used throughout the entire application, the terms "a" and "an" are used in the sense that they mean "at least one", "at least a first", "one or more" or "a plurality" of the referenced components or steps, unless the context clearly dictates otherwise. For example, the term "a cell" includes a plurality of cells, including mixtures thereof.

The term "and/or" wherever used herein includes the meaning of "and", "or" and "all or any other combination of the elements connected by said term".

The term "about" or "approximately" as used herein means within 20%, preferably within 10%, and more preferably within 5% of a given value or range.

As used herein, the terms "comprising" and "comprise" are intended to mean that the kits of parts, products, compositions and methods include the referenced components or steps, but not excluding others. "Consisting essentially of" when used to define products, compositions and methods, shall mean excluding other components or steps of any essential significance. Thus, a composition consisting essentially of the recited components would not exclude trace contaminants and pharmaceutically acceptable carriers. "Consisting of" shall mean excluding more than trace elements of other components or steps.

As used herein, the term "specifically binds to" refers to a binding reaction which is determinative of the presence of a target protein in the presence of a heterogeneous population of proteins and other biologics. Thus, under designated assay conditions, the antibody according to the invention bind preferentially to at least part of the CSF-1R and do not bind in a significant amount to other components present in a test sample. Specific binding between the antibody according to the invention and the CSF-1R target means that the binding affinity is of at least 10^3 M^{-1} , and preferably 10^5 M^{-1} , 10^6 M^{-1} , 10^7 M^{-1} , 10^8 M^{-1} , 10^9 M^{-1} or 10^{10} M^{-1} .

As used herein, the term "CSF-1R" refers to the human CSF1 receptor. The human CSF-1 receptor has been sequenced and its amino acid sequence is depicted in SEQ ID NO: 29.

As used herein, "antibody" or "Ab" is used in the broadest sense. Therefore, an "antibody" or "Ab" can be naturally occurring or man-made such as monoclonal antibodies (mAbs) produced by conventional hybridoma technology, recombinant technology and/or a functional fragment thereof. Antibodies of the present invention are meant to include both intact immunoglobulin molecules for example a polyclonal antibody, a monoclonal antibody (mAb), a monospecific antibody, a bispecific antibody, a polyspecific antibody, a human antibody, an animal antibody (e.g. camelid

antibody), chimeric antibodies, as well as portions, fragments, regions, peptides and derivatives thereof (provided by any known technique, such as, but not limited to, enzymatic cleavage, peptide synthesis, or recombinant techniques), such as, for example, immunoglobulin devoid of light chains (see 5 for example U.S. Pat. No. 6,005,079), Fab, Fab', F (ab')₂, Fv, scFv, antibody fragment, diabody, Fd, CDR regions, or any portion or peptide sequence of the antibody that is capable of binding antigen or epitope. An antibody is said to be "capable of binding" a molecule if it is capable of specifically reacting with the molecule to thereby bind the molecule to the antibody. Antibody fragments or portions may lack the Fc fragment of intact antibody, clear more rapidly from the circulation, and may have less non-specific tissue binding than an intact antibody. Examples of antibody may be produced from intact antibodies using methods well known in the art, for example by proteolytic cleavage with enzymes such as papain (to produce Fab fragments) or pepsin (to produce F(ab')₂ fragments). See e.g., Wahl et al., 24 J. Nucl. Med. 316-25 (1983). Portions of antibodies may be made by any of the above methods, or may be made by expressing a portion of the recombinant molecule. For example, the CDR region(s) of a recombinant antibody may be isolated and subcloned into the appropriate expression vector.

As used herein, the term "variable region" refers to the variable region, or domain, of the light chain (VL) or heavy chain (VH) which contain the determinants for binding recognition specificity. The variable domains are involved in antigen recognition and form the antigen binding site. As used herein, the term "framework region" refers to portions of light and heavy chain variable regions that are at least 85% homologous (i.e., other than the CDR's) among different antibodies in the same specie. As used herein, the term "homologous" refers to a comparison of the amino acids of two polypeptides which, when aligned by using the Smith-Waterman algorithm (SMITH, et al. Identification of common molecular subsequences. *Journal of Molecular Biology*. 1981, no. 147, p. 195-7.), have approximately the designated percentage of the same amino acids. For example, "85% homologous" refers to a comparison of the amino acids of two polypeptides which when optimally aligned have 85% amino acid identity. The variable region of both the heavy and light chain is divided into segments comprising four framework sub-regions (FR1, FR2, FR3, and FR4), interrupted by three stretches of hypervariable sequences, or the complementary determining regions (CDR's), as defined in Kabat's database (Kabat et al., op. cit.), with the CDR1 positioned between FR1 and FR2, CDR2 between FR2 and FR3, and CDR3 between FR3 and FR4. Without specifying the particular sub-regions as FR1, FR2, FR3 or FR4, a framework region as referred by others, represents the combined FR's within the variable region of a single, naturally occurring immunoglobulin chain. As used herein, a FR represents one of the four sub-regions, and FR's represents two or more of the four sub-regions constituting a framework region. The sequences of the framework regions of different light or heavy chains are relatively conserved within a species. The framework region of an antibody is the combined framework regions of the constituent light and heavy chains and serves to position and align the CDR's. The CDR's are primarily responsible for forming the binding site of an antibody conferring binding specificity and affinity to an epitope of an antigen. Within the variable regions of the H or L chains that provide for the antigen binding regions are smaller sequences dubbed "hypervariable" because of their extreme variability between 55 antibodies of differing specificity. Such hypervariable regions are also referred to as "complementarity determining

regions" or " " regions. These CDR regions account for the basic specificity of the antibody for a particular antigenic determinant structure. The CDRs represent non-contiguous stretches of amino acids within the variable regions but, regardless of species, the positional locations of these critical amino acid sequences within the variable heavy and light chain regions have been found to have similar locations within the amino acid sequences of the variable chains. The variable heavy and light chains of all antibodies each have 3 CDR regions, each non-contiguous with the others (termed L1, L2, L3, H1, H2, H3) for the respective light (L) and heavy (H) chains. The accepted CDR regions have been described by Kabat et al, 252 J. Biol. Chem. 6609-16 (1977), and CDR loops may be identified by applying these rules during an examination of a linear amino acid sequence. The rules for defining the CDR-H3 loop can vary, however (see Chapter 4, Antibody Engineering: Methods & Protocols, (Lo, ed. Humana Press, Totowa, N.J., 2004)), and the actual boundaries of some CDR-H3 loops may not be identified without experimental techniques such as circular dichroism, nuclear magnetic resonance, or X-ray crystallography. In all mammalian species, antibody peptides contain constant (i.e., highly conserved) and variable regions, and, within the latter, there are the CDRs and the so-called "framework regions" made up of amino acid sequences within the variable region of the heavy or light chain but outside the CDRs. The CDR regions can also be defined using Chothia nomenclature (CHOTHIA and LESK. Canonical structures for the hypervariable regions of immunoglobulins (1987) J Mol. Biol. 1987 Aug. 20; 196(4):901-17). Therefore, in certain embodiments, the CDRs are Kabat defined CDRs, and in other embodiments, the CDRs are Chothia defined CDRs. Regarding the antigenic determinate recognized by the CDR regions of the antibody, this is also referred to as the "epitope." In other words, epitope refers to that portion of any molecule capable of being recognized by, and bound by, an antibody (the corresponding antibody binding region may be referred to as a paratope). In general, epitopes consist of chemically active surface groupings of molecules, for example, amino acids or sugar side chains, and have specific three-dimensional structural characteristics as well as specific charge characteristics.

The term "monoclonal antibody" or "mAb" as used herein refers to an antibody that is derived from a single clone. Monoclonal antibodies can be prepared using hybridoma techniques such as those disclosed in HARLOW. Antibodies: A Laboratory manual. 2nd edition. Cold Spring Harbor: Laboratory press, 1988. and HAMMERLING, et al. Monoclonal Antibodies and T Cell Hybridomas. New York: Elsevier, 1981. p. 563-681.

As used herein, the term "human antibody" refers to an antibody having variable and constant regions derived from or closely matching human germline immunoglobulin sequences. The human antibody of the invention may include amino acid residues not encoded by human germline immunoglobulin sequences (e.g., mutations introduced by random or site-specific mutagenesis in vitro or by somatic mutation in vivo). Thus, as used herein, the term "human antibody" refers to an antibody in which substantially every part of the protein is substantially similar to a human germline antibody. "Substantially similar" refers to an antibody having a nucleic acid sequence which is at least 80, preferably 85, more preferably 90 and even more preferably 95% homologous to the nucleic acid sequence a human germline antibody.

As used herein, the term "Fab" refers to regions of antibody molecules which include the variable region of the heavy chain and light chain and which exhibit binding activity.

"Fab" includes aggregates of one heavy and one light chain (commonly known as Fab), whether any of the above are covalently or non-covalently aggregated so long as the aggregation is capable of selectively reacting with a particular antigen or antigen family. The Fab fragment is a heterodimer comprising a VL and a second polypeptide comprising the VH and CH1 domains. In a preferred embodiment the antibody is an Fab' fragment. By Fab' fragments differ from Fab fragments in that the Fab' fragment contains a few residues at the carboxy terminus of the heavy chain CH1 domain including one or more cysteines from the antibody "hinge region".

"F(ab')₂" refers to an antibody fragment obtained by the pepsin treatment of an antibody or to the equivalent protein obtained by other techniques such as recombinant technologies. F(ab')₂ fragment has two antigen-combining sites and is still capable of cross-linking an antigen.

"Fv" is the minimum antibody fragment that contains a complete antigen recognition and binding site. This region consists of a dimer of one heavy- and one light-chain variable domain in tight, non-covalent association. It is in this configuration that the three CDRs of each variable domain interact to define an antigen binding site on the surface of the VH VL dimer. Collectively, the six CDRs confer antigen-binding specificity to the antibody. However, even a single variable domain (or half of an Fv comprising only three CDRs specific for an antigen) has the ability to recognize and bind antigen, although at a lower affinity than the entire binding site.

"Single-chain Fv" or "scFv" comprise the VH and VL domains of antibody, wherein these domains are present in a single polypeptide chain. Preferably, the scFv further comprises a polypeptide linker between the VH and VL domains which enables the scFv to form the desired structure for antigen binding (LENNARD. Standard protocols for the construction of scFv libraries. *Methods in molecular biology*. 2002, no. 178, p. 59-71.).

As used herein, the term "antibody fragment" refers to one or more fragments of an antibody that retain the ability to specifically bind to the CSF-1R.

The term "diabodies" refers to small antibody fragments with two antigen-binding sites, which fragments comprise a heavy-chain variable domain (VH) connected to a light-chain variable domain (VL) in the same polypeptide chain (VH VL). By using a linker that is too short to allow pairing between the two domains on the same chain, the domains are forced to pair with the complementary domains of another chain and create two antigen-binding sites. Diabodies may bind to one or more than one epitope. Diabodies are more fully described in POLJAK. Production and structure of diabodies. *Structure*. 1994, vol. 2, no. 12, p. 1121-3., HUDSON, et al. High avidity scFv multimers; diabodies and triabodies. *Journal of immunological methods*. 1999, vol. 231, no. 1-2, p. 177-89. and KIPRIYANOV. Generation of bispecific and tandem diabodies. *Methods in molecular biology*. 2002, no. 178, p. 317-31.

Various techniques have been developed for the production of antibody fragments. Traditionally, these fragments were derived via proteolytic digestion of intact antibodies. However, these fragments can now be produced directly by recombinant host cells. Fab, Fv and scFv antibody fragments can all be expressed in and secreted from *E. coli*, thus allowing the production of large amounts of these fragments. Techniques for the production of antibody fragments will be apparent to the skilled in the art. In other embodiments, the antibody of choice is a single chain Fv fragment (scFv).

As used herein "Domain Antibodies" (dAbs) consist in the smallest functional binding units of antibodies, corresponding to the variable regions of either the heavy (VH) or light

(VL) chains of the antibodies. Domain Antibodies have a molecular weight of approximately 13 kDa, or less than one-tenth the size of a full antibody.

As used herein, "Fd" refers to an antibody fragment that consists of the VH and CH1 domains.

The term "antibody" or "Ab" also refers to other antibody fragment well known to the one skilled in the art, for example those described in HOLLIGER, et al. Engineered antibody fragments and the rise of single domains. *Nature biotechnology*. 2005, vol. 23, no. 9, p. 1126-36. and HOOGENBOOM, et al. Natural and designer binding sites made by phage display technology. *Immunology today*. 2000, vol. 21, no. 8, p. 371-8.

According to one embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises:

- (i) at least one CDR wherein said CDR is comprising at least five consecutive amino acids of the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2, of the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2 or of the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2;

or,

- (ii) at least one CDR wherein said CDR is comprising at least five consecutive amino acids of the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4, of the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4 or of the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises at least one CDR wherein said CDR is, independently from one another, selected in the group of CDRs comprising at least five consecutive amino acids:

- of the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,
- of the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2,
- of the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2,
- of the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,
- of the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4
- or of the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to a preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises 2, 3, 4 or 5 and even more preferably 6 CDRs wherein said CDRs are, independently from one another, selected in the group of CDRs comprising at least five consecutive amino acids:

- of the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,
- of the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2,
- of the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2,
- of the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,
- of the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4
- or of the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to a another preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises:

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(iii) 2 and even more preferably 3 CDRs wherein said CDRs are, independently from one another, selected in the group of CDRs comprising at least five consecutive amino acids:

of the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,

of the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2,

of the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2,

or

(iv) 2 and even more preferably 3 CDRs wherein said CDRs are, independently from one another, selected in the group of CDRs comprising at least five consecutive amino acids:

of the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,

of the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4

or of the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises:

(i) at least one CDR selected, independently from one another, in the group of the CDR as set forth in:

the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,

the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2 and

the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2; or

(ii) at least one CDR selected, independently from one another, in the group of the CDR as set forth in:

the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,

the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4 and

the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises at least one CDR selected, independently from one another, in the group of the CDR as set forth in:

the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,

the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2,

the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2,

the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,

the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4 and

the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises 2, 3, 4 or 5 and even more preferably 6 CDRs selected, independently from one another, in the group of the CDR as set forth in:

the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,

the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2,

the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2,

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the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,

the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4 and

the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to a another preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises:

(iv) 2 and even more preferably 3 CDRs wherein said CDRs are, independently from one another, selected in the group of the CDRs as set forth in:

the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,

the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2,

the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2,

or

(iv) 2 and even more preferably 3 CDRs wherein said CDRs are, independently from one another, selected in the group of the CDRs as set forth in:

the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,

the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4,

the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to one embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises (i) at least one CDR comprising an amino acid sequence as set forth in any one of SEQ ID NOS: 11, 12, or 13; or (ii) at least one CDR comprising an amino acid sequence as set forth in any one of SEQ ID NOS: 14, 15 or 16.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises at least one CDR comprising an amino acid sequence as set forth in any one of SEQ ID NOS: 11, 12, 13, 14, 15 or 16.

According to a preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises 2, 3, 4, 5 and even more preferably 6 CDRs comprising an amino acid sequence as set forth in any one of SEQ ID NOS: 11, 12, 13, 14, 15 or 16.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises (i) at least one CDR as set forth in any one of SEQ ID NOS: 11, 12 or 13; or (ii) at least one CDR set forth in any one of SEQ ID NOS: 14, 15 or 16.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises at least one CDR as set forth in any one of SEQ ID NOS: 11, 12, 13, 14, 15 or 16.

According to one preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises 2, 3, 4, 5 and even more preferably 6 CDRs as set forth in any one of SEQ ID NOS: 11, 12, 13, 14, or 16.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises (i) at least one CDR comprising an amino acid sequence as set forth in any one of SEQ ID NOS: 17, 18 or 19; or (ii) at least one CDR comprising an amino acid sequence as set forth in any one of SEQ ID NOS: 20, 21 or 22.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises at least one CDR comprising an amino acid sequence as set forth in any one of SEQ ID NOS: 17, 18, 19, 20, 21 or 22.

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According to one preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises 2, 3, 4, 5 and even more preferably 6 CDRs comprising an amino acid sequence as set forth in any one of SEQ ID NOs: 17, 18, 19, 20, 21 or 22.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises (i) at least one CDR as set forth in any one of SEQ ID NOs: 17, 18 or 19; or (ii) at least one CDR as set forth in any one of SEQ ID NOs: 20, 21 or 22.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises at least one CDR set forth in any one of SEQ ID NOs: 17, 18, 19, 20, 21 or 22.

According to one preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises 2, 3, 4, 5 and even more preferably 6 CDRs as set forth in any one of SEQ ID NOs: 17, 18, 19, 20, 21 or 22.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises (i) at least one CDR comprising an amino acid sequence as set forth in any one of SEQ ID NOs: 23, 24 or 25; or (ii) at least one CDR comprising an amino acid sequence as set forth in any one of SEQ ID NOs: 26, 27 or 28.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises at least one CDR comprising an amino acid sequence as set forth in any one of SEQ ID NOs: 23, 24, 25, 26, 27 or 28.

According to one preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises 2, 3, 4, 5 and even more preferably 6 CDRs comprising an amino acid sequence as set forth in any one of SEQ ID NOs: 23, 24, 25, 26, 27 or 28.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises (i) at least one CDR as set forth in any one of SEQ ID NOs: 23, 24 or 25; or (ii) at least one CDR as set forth in any one of SEQ ID NOs: 26, 27 or 28.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises at least one CDR as set forth in any one of SEQ ID NOs: 23, 24, 25, 26, 27 or 28.

According to one preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises 2, 3, 4, 5 and even more preferably 6 CDRs as set forth in any one of SEQ ID NOs: 23, 24, 25, 26, 27 or 28.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein said variable region comprises the CDRs as set forth in:

- the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,
- the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2 and
- the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein said variable region comprises the CDRs as set forth in:

- the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,
- the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4 and
- the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

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According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein said variable region comprises the three CDRs as set forth in SEQ ID NOs: 11, 12, and 13.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein said variable region comprises the three CDRs as set forth in SEQ ID NOs: 14, 15, and 16.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein said variable region comprises the three CDRs set forth in SEQ ID NOs: 17, 18, and 19.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein said variable region comprises the three CDRs as set forth in SEQ ID NOs: 20, 21, and 22.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein said variable region comprises the three CDRs as set forth in SEQ ID NOs: 23, 24, and 25.

According to another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein said variable region comprises the three CDRs as set forth in SEQ ID NOs: 26, 27, and 28.

In preferred embodiments, the said variable region further comprises one, more preferably two, even more preferably three and definitely preferably four framework region, and more preferably human FR. As used herein, a "human FR" is a framework region that is at least 75% homologous to the framework region of a naturally occurring human antibody.

According to one preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein the variable region comprises an amino acid sequence as set forth in SEQ ID NO:6.

In a more preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein the variable region is as set forth in SEQ ID NO:6.

In another preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein the variable region comprises an amino acid sequence as set forth in SEQ ID NO:9.

In another more preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises a variable region, wherein the variable region is as set forth in SEQ ID NO:9.

In another embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises two variable regions, wherein the variable regions are, independently from one another, selected in the group of

- (i) variable regions comprising the CDRs as set forth in:
 - the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,
 - the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2 and
 - the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2;
- (ii) variable regions comprising the CDR as set forth in:
 - the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,
 - the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4 and
 - the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4;
- (ii) variable regions comprising the three CDRs set forth in SEQ ID NOs: 11, 12, and 13;

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(ii) a variable region as set forth in SEQ ID NO:9.

According to another preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and is a scFv, wherein said scFv comprises:

(i) a heavy-chain variable region comprising:

the CDR set forth in the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,

the CDR set forth in the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2 and

the CDR set forth in the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2

and

(ii) a light-chain variable region comprising:

the CDR set forth in the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,

the CDR set forth in the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4 and

the CDR set forth in the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to another preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and is a scFv, wherein said scFv comprises:

(i) a heavy-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 11, 12, and 13, and

(ii) a light-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 14, 15, and 16.

According to another preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and is a scFv, wherein said scFv comprises:

(i) a heavy-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 17, 18, and 19, and

(ii) a light-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 20, 21, and 22.

According to another preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and is a scFv, wherein said scFv comprises:

(i) a heavy-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 23, 24, and 25, and

(ii) a light-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 26, 27, and 28.

According to a more preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and is a scFv, wherein said scFv comprises:

(i) the heavy-chain variable region as set forth in SEQ ID NO:6 and

(ii) the light-chain variable region as set forth in SEQ ID NO:9.

In an even more preferred embodiment, the scFv is provided wherein at least one amino acid is substituted (according to Table 1 and Table 2) within the amino acid sequence as set forth in SEQ ID NO 6 and 9. In a definitely preferred embodiment the human antibody is provided wherein all the amino acid depicted in Table 1 and Table 2 are substituted (according to Table 1 and Table 2) within the amino acid sequence as set forth in SEQ ID NO 6 and 9.

According to another preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises the heavy chain as set forth in SEQ ID NO:2.

According to another preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises the light chain as set forth in SEQ ID NO:4.

According to a more preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and comprises the heavy chain as set forth in SEQ ID NO:2 and the light chain as set forth in SEQ ID NO:4.

According to an even more preferred embodiment, the antibody of the Invention binds specifically to CSF-1R and

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comprises two heavy chains as set forth in SEQ ID NO:2 and two light chain as set forth in SEQ ID NO:4. This particular antibody will be named CXIIG6 throughout the present application.

According to another preferred embodiment, the present invention relates to a human antibody, that specifically binds to CSF-1R, comprising:

(i) a heavy-chain variable region comprising:

the CDR as set forth in the sequence starting in position 45 and finishing in position 54 of SEQ ID NO:2,

the CDR as set forth in the sequence starting in position 66 and finishing in position 87 of SEQ ID NO:2 and

the CDR as set forth in the sequence starting in position 117 and finishing in position 126 of SEQ ID NO:2;

and

(ii) a light-chain variable region comprising:

the CDR as set forth in the sequence starting in position 44 and finishing in position 56 of SEQ ID NO:4,

the CDR as set forth in the sequence starting in position 66 and finishing in position 76 of SEQ ID NO:4 and

the CDR as set forth in the sequence starting in position 109 and finishing in position 117 of SEQ ID NO:4.

According to another embodiment, the present invention relates to an human antibody, that specifically binds to CSF-1R, comprising:

(i) a heavy-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 11, 12, and 13, and

(ii) a light-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 14, 15, and 16.

According to another embodiment, the present invention relates to an human antibody, that specifically binds to CSF-1R, comprising:

(i) a heavy-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 17, 18, and 19, and

(ii) a light-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 20, 21, and 22.

According to another embodiment, the present invention relates to an human antibody, that specifically binds to CSF-1R, comprising:

(i) a heavy-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 23, 24, and 25, and

(ii) a light-chain variable region comprising the three CDRs as set forth in SEQ ID NOs: 26, 27, and 28.

According to a preferred embodiment, the present invention relates to an human antibody, that specifically binds to CSF-1R, comprising:

(i) the heavy-chain variable region set forth in SEQ ID NO:6 and

(ii) the light-chain variable region set forth in SEQ ID NO:9.

In a more preferred embodiment, the human antibody is provided wherein at least one amino acid is substituted (according to Table 1 and Table 2) within the amino acid sequence as set forth in SEQ ID NO: 6 and 9. In a even more preferred embodiment the human antibody is provided wherein all the amino acid depicted in Table 1 and Table 2 are substituted (according to Table 1 and Table 2) within the amino acid sequence as set forth in SEQ ID NO: 6 and 9.

TABLE 1

SEQ ID NO: 6	position	Preferred substitution
K	3	Q
E	5	V
M	18	L
K	19	R

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TABLE 1-continued

SEQ ID NO: 6	position	Preferred substitution
W	33	Y
S	40	A
E	42	G
M	43	K
A	49	G
E	50	R
I	51	T
A	59	T
F	61	E
E	64	A
S	79	N
V	81	L
R	89	K
P	90	T, A
G	94	A
I	95	V
T	99	A
N	107	Y, V
T	113	L
L	114	V

TABLE 2

SEQ ID NO: 9	Position	Preferred substitution
A	9	S
V	13	A
E	17	D
T	18	R
E	27	Q
N	28	G
Q	40	P, D
S	43	A
Q	45	K
V	48	L
H	49	Y
N	53	R
A	55	E
D	56	S
Q	70	D
Y	71	F
S	72	T
K	74	T
N	76	S
S	80	P
G	84	A
S	85	T
H	90	Q
G	100	Q

The antibody, more specifically the human antibody, according to the invention may be of different isotypes, such as IgG, IgA, IgM or IgE. In a preferred embodiment the antibody, more specifically the human antibody, according to the invention is an IgG.

In a related embodiment, the human antibody comprises a modified or unmodified constant region of a human IgG1, IgG2, IgG3 or IgG4. In a preferred embodiment, the constant region is human IgG1 or IgG4, which may optionally be modified to enhance or decrease certain properties.

In the case of IgG1, modifications to the constant region, particularly the hinge or CH2 region, may increase or decrease effector function, including ADCC and/or CDC activity. In other embodiments, an IgG2 constant region is modified to decrease antibody-antigen aggregate formation. In the case of IgG4, modifications to the constant region, particularly the hinge region, may reduce the formation of half-antibodies.

The desired binding affinity may be retained even though one or more of the amino acids in the antibody are mutated. These variants have at least one amino acid in the antibody

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replaced by a different residue. According to another embodiment, the present invention provides an antibody that specifically binds to CSF1 as above described in which at least one of the amino acid comprised in the CDR(s) is conservatively substituted. Conservative substitutions are shown in Table 3.

TABLE 3

Original Amino Acid	Preferred conservative substitution	More preferred conservative substitution
A	V, L, I	V
R	K, Q, N	K
N	Q, H, D, K, R	Q
D	E, N	E
C	S, A	S
Q	N, E	N
E	D, Q	D
G	A	A
H	N, Q, K, R	R
I	L, V, M, A, F	L
L	I, V, M, A, F	I
K	R, Q, N	R
M	L, F, I	L
F	W, L, V, I, A, Y	Y
P	A	A
S	T	T
T	V, S	S
W	Y, F	Y
Y	W, F, T, S	F
V	L, M, F, A	L

The present invention also relates to a process of modifying the antibody of the invention by affinity maturation.

As used herein, "affinity maturation" refers to the substitution of one or more amino acid comprised in one or more CDRs, said substitution resulting in an improvement in the affinity of the antibody to CSF-1R, compared to a parent antibody which does not possess those substitution(s). Affinity maturation processes are known in the art. See for example methods disclosed in MARKS, et al. By-passing immunization: building high affinity human antibodies by chain shuffling. *Biotechnology*. 1992, vol. 10, no. 7, p. 779-83.; BAR-BAS, et al. In vitro evolution of a neutralizing human antibody to human immunodeficiency virus type 1 to enhance affinity and broaden strain cross-reactivity. *Proceedings of the National Academy of Sciences of the United States of America*. 1994, vol. 91, no. 9, p. 3809-13.; SCHIER. Identification of functional and structural amino-acid residues by parsimonious mutagenesis. *Gene*. 1996, vol. 169, no. 2, p. 147-55.; YELTON. Affinity maturation of the BR96 anti-carcinoma antibody by codon-based mutagenesis. *J. immunol.* 1995, vol. 155, no. 4, p. 1994-2004.; JACKSON, et al. In vitro antibody maturation. Improvement of a high affinity, neutralizing antibody against IL-1 beta. *J. immunol.* 1995, vol. 154, no. 7, p. 3310-9. and HAWKINS, et al. Selection of phage antibodies by binding affinity. Mimicking affinity maturation. *Journal of molecular biology*. 1992, vol. 226, no. 3, p. 889-96.

The present invention also relates to an antibody, that specifically binds to CSF-1R, obtained by affinity maturation as previously described.

In another embodiment, the present invention provides variants of the antibody previously described, having an amino acid sequence which is at least 80%, preferably at least 85%, more preferably at least 90%, and even more preferably at least 98% homologous to the amino acid sequence of the previously described antibody.

In another embodiment, the antibody according to the invention specifically binds to more than one epitope. For example, the antibody according to the invention may bind to

two different epitopes of CSF-1R. Alternatively, the antibody according to the invention can be able to bind to CSF-1R and to another molecule. As used herein, antibodies that specifically bind to more than one epitope can be cross-linked antibodies. For example, an antibody can be coupled to avidin, the other to biotin. Cross-linked antibodies may be made using any convenient cross-linking methods well known in the art. Techniques for generating bispecific antibodies from antibody fragments have also been described, see for example BRENNAN, et al. Preparation of bispecific antibodies by chemical recombination of monoclonal immunoglobulin G1 fragments. *Science*. 1985, vol. 229, no. 4708, p. 81-3. and SHALABY, et al. Development of humanized bispecific antibodies reactive with cytotoxic lymphocytes and tumor cells overexpressing the HER2 protooncogene. *The Journal of experimental medicine*. 1992, vol. 175, no. 1, p. 217-25. KOSTELNY, et al. Formation of a bispecific antibody by the use of leucine zippers. *J. immunol.* 1992, vol. 148, no. 5, p. 1547-33.

According to a preferred embodiment, the antibody that specifically binds to more than one epitope according to the invention is a diabody.

According to another preferred embodiment, the antibody that specifically binds to more than one epitope according to the invention is a linear antibody as described in ZAPATA, et al. Engineering linear F(ab')₂ fragments for efficient production in *Escherichia coli* and enhanced antiproliferative activity. *Protein engineering*. 1995, vol. 8, no. 10, p. 1057-62.

The antibody according to the invention may be glycosylated or non-glycosylated.

As used herein, the term "glycosylation" refers to the presence of carbohydrate units that are covalently attached to the antibody.

In another embodiment, the antibody according to the invention is conjugated to a radiosensitizer agent, a receptor and/or a cytotoxic agent

As used herein, the term "radiosensitizer" refers to a molecule that makes cells more sensitive to radiation therapy. Radiosensitizer includes, but are not limited to, metronidazole, misonidazole, desmethylmisonidazole, pimonidazole, etanidazole, nimorazole, mitomycin C, RSU 1069, SR 4233, EO9, RB 6145, nicotinamide, 5-bromodeoxyuridine (BUdR), iododeoxyuridine (IUdR), bromodeoxycytidine, fluorodeoxyuridine (FUdR), hydroxyurea and cisplatin.

As used herein, the term "receptor" refers to a compound able to specifically bind to a ligand. According to a preferred embodiment of the invention, the receptor is biotin.

As used herein, the term cytotoxic agent refers to a compound that is directly toxic to cells, preventing their reproduction or growth. According to a preferred embodiment, the cytotoxic agent used in the context of the present invention is chosen from the group comprising cancer therapeutic agent, toxin (e.g., an enzymatically active toxin of bacterial, fungal, plant or animal origin, or fragments thereof), or a radioactive isotope.

In another embodiment, the antibody according to the invention is conjugated to a labelling agent

As used herein, "a labelling agent" refers to a detectable compound. The labelling agent may be detectable by itself (e.g., radioisotope labels or fluorescent labels) or, in the case of an enzymatic label, may catalyze chemical modification of a substrate compound which is detectable.

As used herein, the term "conjugated" means that the antibody according to the invention and the labelling agent are covalently or non-covalently linked.

"Covalent link" refers to coupling through reactive functional groups, optionally with the intermediary use of a cross

linker or other activating agent (see for example HERMANSON. Bioconjugate techniques. Academic press, 1996.). The antibody according to the invention and/or the conjugated agent may be modified in order to allow their coupling via, for example, substitution on an activated carbonyl group (including those activated in situ) or on an imidoester, via addition on an unsaturated carbonyl group, by reductive amination, nucleophilic substitution on a saturated carbon atom or on a heteroatom, by reaction on aromatic cycles. In particular, coupling may be done using homobifunctional or heterobifunctional cross-linking reagents. Homobifunctional cross linkers including glutaraldehyde, succinic acid and bis-imidoester like DMS (dimethyl suberimidate) can be used to couple amine groups which may be present on the various moieties. Numerous examples are given in HERMANSON. Bioconjugate techniques. Academic press, 1996. p. 118-228. which are well known by those of the art. Heterobifunctional cross linkers include those having both amine reactive and sulphydryl-reactive groups, carbonyl-reactive and sulphydryl-reactive groups and sulphydryl-reactive groups and photoreactive linkers. Suitable heterobifunctional cross-linkers are, for example, described in HERMANSON. Bioconjugate techniques. Academic press, 1996. p. 229-285. Examples are, for example, SPDP(N-succinimidyl 3-(2-pyridyldithio) propionate), SMBP (succinimidyl-4-(p-maleimidophenyl) butyrate), SMPT (succinimidyl-oxycarbonyl-methyl-(2-pyridyldithio) toluene), MBS (m-maleimidobenzoyl-N-hydroxysuccinimide ester), STAB (N-succinimidyl (4-iodoacetyl)aminobenzoate), GMBS (γ -maleimidobutyryloxy succinimide ester), SIAX (succinimidyl-6-iodoacetyl amino hexonate, SIAC (succinimidyl-4-iodoacetyl amino methyl), NP1A (p-nitrophenyl iodoacetate). Other examples are useful to couple carbohydrate-containing molecules (e.g. env glycoproteins, antibodies) to sulphydryl-reactive groups. Examples include MPBH (4-(4-N maleimidophenyl) butyric acid hydrazide) and PDPH (4-(N-maleimidomethyl)cyclohexane-1-carboxyl-hydrazide (M2C2H and 3-2(2-pyridyldithio) propionyl hydrazide).

According to another embodiment, the present invention relates to a nucleic acid sequence coding the antibody of the invention.

The term "nucleic acid sequence" refers to a linear sequence of nucleotides. The nucleotides are either a linear sequence of polyribonucleotides or polydeoxyribonucleotides, or a mixture of both. Examples of polynucleotides in the context of the present invention include single and double stranded DNA, single and double stranded RNA, and hybrid molecules that have both mixtures of single and double stranded DNA and RNA. Further, the polynucleotides of the present invention may have one or more modified nucleotides.

According to a preferred embodiment of the invention, the nucleic acid sequence according to the invention is comprised in a vector.

The vector can be of plasmid or viral origin and can, where appropriate, be combined with one or more substances which improve the transfectional efficiency and/or stability of the vector. These substances are widely documented in the literature which is available to the skilled person (see, for example, FELGNER, et al. Cationic liposome mediated transfection. *Proceedings of the Western Pharmacology Society*. 1989, vol. 32, p. 115-21.; HODGSON, et al. Virosomes: cationic liposomes enhance retroviral transduction. *Nature biotechnology*. 1996, vol. 14, no. 3, p. 339-42.; REMY, et al. Gene transfer with a series of lipophilic DNA-binding molecules. *Bioconjugate chemistry*. 1994, vol. 5, no. 6, p. 647-54.). By way of non-limiting illustration, the substances can be polymers,

lipids, in particular cationic lipids, liposomes, nuclear proteins or neutral lipids. These substances can be used alone or in combination. A combination which can be envisaged is that of a recombinant plasmid vector which is combined with cationic lipids (DOGS, DC-CHOL, spermine-chol, spermidine-chol, etc.), lysophospholipides (for example Hexadecylphosphocholine) and neutral lipids (DOPE).

According to a preferred embodiment, the cationic lipids which can be used in the present invention are the cationic lipids describes in EP 901463 B and more preferably pcTG90.

The choice of the plasmids which can be used within the context of the present invention is huge. They can be cloning vectors and/or expression vectors. In a general manner, they are known to the skilled person and, while a number of them are available commercially, it is also possible to construct them or to modify them using the techniques of genetic manipulation. Examples which may be mentioned are the plasmids which are derived from pBR322 (Gibco BRL), pUC (Gibco BRL), pBluescript (Stratagene), pREP4, pCEP4 (Invitrogen) or p Poly (LATHE, et al. Plasmid and bacteriophage vectors for excision of intact inserts. *Gene*. 1987, vol. 57, no. 2-3, p. 193-201.). Preferably, a plasmid which is used in the context of the present invention contains an origin of replication which ensures that replication is initiated in a producer cell and/or a host cell (for example, the ColE1 origin will be chosen for a plasmid which is intended to be produced in *E. coli* and the oriP/EBNA1 system will be chosen if it desired that the plasmid should be self-replicating in a mammalian host cell, LUPTON, et al. Mapping genetic elements of Epstein-Barr virus that facilitate extrachromosomal persistence of Epstein-Barr virus-derived plasmids in human cells. *Molecular and cellular biology*. 1985, vol. 5, no. 10, p. 2533-42.; YATES, et al. Stable replication of plasmids derived from Epstein-Barr virus in various mammalian cells. *Nature*. 1985, vol. 313, no. 6005, p. 812-5.). The plasmid can additionally comprise a selection gene which enables the transfected cells to be selected or identified (complementation of an auxotrophic mutation, gene encoding resistance to an antibiotic, etc.). Naturally, the plasmid can contain additional elements which improve its maintenance and/or its stability in a given cell (cer sequence, which promotes maintenance of a plasmid in monomeric form (SUMMERS, et al. Multimerization of high copy number plasmids causes instability: ColE1 encodes a determinant essential for plasmid monomerization and stability. *Cell*. 1984, vol. 36, no. 4, p. 1097-103., sequences for integration into the cell genome).

With regard to a viral vector, it is possible to envisage a vector which is derived from a poxvirus (vaccinia virus, in particular MVA, canarypoxvirus, etc.), from an adenovirus, from a retrovirus, from a herpesvirus, from an alphavirus, from a foamy virus or from an adenovirus-associated virus. It is possible to use replication competent or replication deficient viral vectors. Preference will be given to using a vector which does not integrate. In this respect, adenoviral vectors and vectors deriving from poxvirus and more preferably vaccinia virus and MVA are very particularly suitable for implementing the present invention.

According to a preferred embodiment, the viral vector according to the invention derives from a Modified Vaccinia Virus Ankara (MVA). MVA vectors and methods to produce such vectors are fully described in European patents EP 83286 A and EP 206920 A, as well as in SUTTER, et al. Nonreplicating vaccinia vector efficiently expresses recombinant genes. *Proc. Natl. Acad. Sci. U.S.A.* 1992, vol. 89, no. 22, p. 10847-51. According to a more preferred embodiment, the nucleic acid sequence according to the invention may be

inserted in deletion I, II, III, IV, V and VI of the MVA vector and even more preferably in deletion III (MEYER, et al. Mapping of deletions in the genome of the highly attenuated vaccinia virus MVA and their influence on virulence. *The Journal of general virology*. 1991, vol. 72, no. Pt5, p. 1031-8.; SUTTER, et al. A recombinant vector derived from the host range-restricted and highly attenuated MVA strain of vaccinia virus stimulates protective immunity in mice to influenza virus. *Vaccine*. 1994, vol. 12, no. 11, p. 1032-40.).

Retroviruses have the property of infecting, and in most cases integrating into, dividing cells and in this regard are particularly appropriate for use in relation to cancer. A recombinant retrovirus according to the invention generally contains the LTR sequences, an encapsidation region and the nucleotide sequence according to the invention, which is placed under the control of the retroviral LTR or of an internal promoter such as those described below. The recombinant retrovirus can be derived from a retrovirus of any origin (murine, primate, feline, human, etc.) and in particular from the MoMuLV (Moloney murine leukemia virus), MVS (Murine sarcoma virus) or Friend murine retrovirus (Fb29). It is propagated in an encapsidation cell line which is able to supply in trans the viral polypeptides gag, pol and/or env which are required for constituting a viral particle. Such cell lines are described in the literature (PA317, Psi CRIP GP+Am-12 etc.). The retroviral vector according to the invention can contain modifications, in particular in the LTRs (replacement of the promoter region with a eukaryotic promoter) or the encapsidation region (replacement with a heterologous encapsidation region, for example the VL30 type) (see U.S. Pat. No. 5,747,323)

Preference will be also given to using an adenoviral vector which lacks all or part of at least one region which is essential for replication and which is selected from the E1, E2, E4 and L1-L5 regions in order to avoid the vector being propagated within the host organism or the environment. A deletion of the E1 region is preferred. However, it can be combined with (an) other modification(s)/deletion(s) affecting, in particular, all or part of the E2, E4 and/or L1-L5 regions, to the extent that the defective essential functions are complemented in trans by means of a complementing cell line and/or a helper virus. In this respect, it is possible to use second-generation vectors of the state of the art (see, for example, international applications WO 94/28152 and WO 97/04119). By way of illustration, deletion of the major part of the E1 region and of the E4 transcription unit is very particularly advantageous. For the purpose of increasing the cloning capacities, the adenoviral vector can additionally lack all or part of the non-essential E3 region. According to another alternative, it is possible to make use of a minimal adenoviral vector which retains the sequences which are essential for encapsidation, namely the 5' and 3' ITRs (Inverted Terminal Repeat), and the encapsidation region. The various adenoviral vectors, and the techniques for preparing them, are known (see, for example, GRAHAM, et al. *Methods in molecular biology*. Edited by MURREY. The human press inc, 1991. p. 109-128.).

Furthermore, the origin of the adenoviral vector according to the invention can vary both from the point of view of the species and from the point of view of the serotype. The vector can be derived from the genome of an adenovirus of human or animal (canine, avian, bovine, murine, ovine, porcine, simian, etc.) origin or from a hybrid which comprises adenoviral genome fragments of at least two different origins. More particular mention may be made of the CAV-1 or CAV-2 adenoviruses of canine origin, of the DAV adenovirus of avian origin or of the Bad type 3 adenovirus of bovine origin (ZAKHARCHUK, et al. Physical mapping and homology

studies of egg drop syndrome (EDS-76) adenovirus DNA. *Archives of virology*. 1993, vol. 128, no. 1-2, p. 171-6.; SPIBEY, et al. Molecular cloning and restriction endonuclease mapping of two strains of canine adenovirus type 2. *The Journal of general virology*. 1989, vol. 70, no. Pt 1, p. 165-72.; JOUVENNE, et al. Cloning, physical mapping and cross-hybridization of the canine adenovirus types 1 and 2 genomes. *Gene*. 1987, vol. 60, no. 1, p. 21-8.; MITTAL, et al. Development of a bovine adenovirus type 3-based expression vector. *The Journal of general virology*. 1995, vol. 76, no. Pt 1, p. 93-102.). However, preference will be given to an adenoviral vector of human origin which is preferably derived from a serotype C—adenovirus, in particular a type 2 or 5 serotype C adenovirus.

The term “replication-competent” as used herein refers to a viral vector capable of replicating in a host cell in the absence of any trans-complementation.

According to a preferred embodiment of the invention, the replication competent vector is a replication competent adenoviral vector. These replication competent adenoviral vectors are well known by the one skilled in the art. Among these, adenoviral vectors deleted in the E1b region coding the 55 kD p53 inhibitor, as in the ONYX-015 virus (BISCHOFF, et al. An adenovirus mutant that replicates selectively in p53-deficient human tumor cells. *Science*. 1996, vol. 274, no. 5286, p. 373-6.; He HEISE, et al. An adenovirus E1A mutant that demonstrates potent and selective systemic anti-tumoral efficacy. *Nature Medicine*. 2000, vol. 6, no. 10, p. 1134-9.; WO 94/18992), are particularly preferred. Accordingly, this virus can be used to selectively infect and kill p53-deficient neoplastic cells. A person of ordinary skill in the art can also mutate and disrupt the p53 inhibitor gene in adenovirus 5 or other viruses according to established techniques. Adenoviral vectors deleted in the E1A Rb binding region can also be used in the present invention. For example, Delta24 virus which is a mutant adenovirus carrying a 24 base pair deletion in the E1A region (FUEYO, et al. A mutant oncolytic adenovirus targeting the Rb pathway produces anti-glioma effect in vivo. *Oncogene*. 2000, vol. 19, no. 1, p. 2-12.). Delta24 has a deletion in the Rb binding region and does not bind to Rb. Therefore, replication of the mutant virus is inhibited by Rb in a normal cell. However, if Rb is inactivated and the cell becomes neoplastic, Delta24 is no longer inhibited. Instead, the mutant virus replicates efficiently and lyses the Rb-deficient cell.

An adenoviral vector according to the present invention can be generated in vitro in *Escherichia coli* (*E. coli*) by ligation or homologous recombination (see, for example, international application WO 96/17070) or else by recombination in a complementing cell line.

According to a preferred embodiment of the invention, the vector further comprises the elements necessary for the expression of the antibody according to the invention.

The elements necessary for the expression consist of all the elements which enable the nucleic acid sequence to be transcribed into RNA and the mRNA to be translated into polypeptide. These elements comprise, in particular, a promoter which may be regulable or constitutive. Naturally, the promoter is suited to the chosen vector and the host cell. Examples which may be mentioned are the eukaryotic promoters of the PGK (phosphoglycerate kinase), MT (methionine), MCIVOR. Human purine nucleoside phosphorylase and adenosine deaminase: gene transfer into cultured cells and murine hematopoietic stem cells by using recombinant amphotropic retroviruses. *Molecular and cellular biology*. 1987, vol. 7, no. 2, p. 838-46.), α -1 antitrypsin, CFTR, surfactant, immunoglobulin, actin (TABIN, et al. Adaptation

of a retrovirus as a eucaryotic vector transmitting the herpes simplex virus thymidine kinase gene. *Molecular and cellular biology*. 1982, vol. 2, no. 4, p. 426-36.) and SR α (TAKEBE, et al. SR alpha promoter: an efficient and versatile mammalian cDNA expression system composed of the simian virus 40 early promoter and the R-U5 segment of human T-cell leukemia virus type 1 long terminal repeat. *Molecular and cellular biology*. 1988, vol. 8, no. 1, p. 466-72.) genes, the early promoter of the SV40 virus (Simian virus), the LTR of RSV (Rous sarcoma virus), the HSV-1 TK promoter, the early promoter of the CMV virus (Cytomegalovirus), the p7.5K pH5R, pK1L, p28 and p11 promoters of the vaccinia virus, chimeric promoters such as p11K7.5 and the E1A and MLP adenoviral promoters. The promoter can also be a promoter which stimulates expression in a tumor or cancer cell. Particular mention may be made of the promoters of the MUC-I gene, which is overexpressed in breast and prostate cancers (CHEN, et al. Breast cancer selective gene expression and therapy mediated by recombinant adenoviruses containing the DF3/MUC1 promoter. *The Journal of clinical investigation*. 1995, vol. 96, no. 6, p. 2775-82.), of the CEA (standing for carcinoma embryonic antigen) gene, which is overexpressed in colon cancers (SCHREWE, et al. Cloning of the complete gene for carcinoembryonic antigen: analysis of its promoter indicates a region conveying cell type-specific expression. *Molecular and cellular biology*. 1990, vol. 10, no. 6, p. 2738-48.) of the tyrosinase gene, which is overexpressed in melanomas (VILE, et al. Use of tissue-specific expression of the herpes simplex virus thymidine kinase gene to inhibit growth of established murine melanomas following direct intratumoral injection of DNA. *Cancer res*. 1993, vol. 53, no. 17, p. 3860-4.), of the ERBB-2 gene, which is overexpressed in breast and pancreatic cancers (HARRIS, et al. Gene therapy for cancer using tumour-specific prodrug activation. *Gene therapy*. 1994, vol. 1, no. 3, p. 170-5.) and of the α -fetoprotein gene, which is overexpressed in liver cancers (KANAI, et al. In vivo gene therapy for alpha-fetoprotein-producing hepatocellular carcinoma by adenovirus-mediated transfer of cytosine deaminase gene. *Cancer res*. 1997, vol. 57, no. 3, p. 461-5.). The cytomegalovirus (CMV) early promoter is very particularly preferred.

However, when a vector deriving from a Vaccinia Virus (as for example an MVA vector) is used, the promoter of the thymidine kinase 7.5K gene and the pH5R promoter are particularly preferred.

The necessary elements can furthermore include additional elements which improve the expression of the nucleic acid sequence according to the invention or its maintenance in the host cell. Intron sequences, secretion signal sequences, nuclear localization sequences, internal sites for the reinitiation of translation of IRES type, transcription termination poly

A sequences, tripartite leaders and origins of replication may in particular be mentioned. These elements are known to the skilled person. Among secretion signal sequence, sequences encoding the polypeptides as set forth in SEQ ID NO 5 and/or 8 are particularly preferred.

The recombinant vector according to the invention can also comprise one or more additional genes of interest, with it being possible for these genes to be placed under the control of the same regulatory elements (polycistronic cassette) or of independent elements. Genes which may in particular be mentioned are the genes encoding interleukins IL-2, IL-4, IL-7, IL-10, IL-12, IL-15, IL-18, chemokines as CCL19, CCL20, CCL21, CXCL-14, interferons, tumor necrosis factor (TNF), and factors acting on innate immunity and angiogenesis (for example PAI-1, standing for plasminogen acti-

vator inhibitor). In one particular embodiment, the recombinant vector according to the invention comprises the gene of interest encoding IL-2.

The present invention also relates to a cell comprising the nucleic acid sequence according to the invention. In a preferred embodiment, the cell according to the invention is eukaryotic cell and more preferably a mammalian cell. Mammalian cells available as hosts for expression are well known in the art and include many immortalized cell lines, such as but not limited to, Chinese Hamster Ovary (CHO) cells, Baby Hamster Kidney (BHK) cells and many others. Suitable additional eukaryotic cells include yeast and other fungi.

The present invention also relates to a process for producing an antibody according to the invention comprising culturing the cell according to the invention under conditions permitting expression of the antibody and purifying the antibody from the cell or medium surrounding the cell.

In another embodiment, the present invention relates to a pharmaceutical composition comprising any one of the antibody, the nucleic acid sequence or the vector according to the invention and a pharmaceutically acceptable carrier. In a preferred embodiment, the pharmaceutical composition further comprises a compound of interest.

The pharmaceutically acceptable carrier is preferably isotonic, hypotonic or weakly hypertonic and has a relatively low ionic strength, such as for example a sucrose solution. Moreover, such a carrier may contain any solvent, or aqueous or partially aqueous liquid such as nonpyrogenic sterile water. The pH of the pharmaceutical composition is, in addition, adjusted and buffered so as to meet the requirements of use in vivo. The pharmaceutical composition may also include a pharmaceutically acceptable diluent, adjuvant or excipient, as well as solubilizing, stabilizing and preserving agents. For injectable administration, a formulation in aqueous, non-aqueous or isotonic solution is preferred. It may be provided in a single dose or in a multidose in liquid or dry (powder, lyophilisate and the like) form which can be reconstituted at the time of use with an appropriate diluent.

The present invention also relates, to a kit of part comprising (i) a pharmaceutical composition, an antibody, a nucleic acid sequence or a vector according to the invention and, (ii) a compound of interest.

As used herein the term, "compound of interest" relates to a therapeutic compound and preferably to a cancer therapeutic agent or a compound useful in the treatment of bone mass decrease.

According to a preferred embodiment, the cancer therapeutic agent is chosen from the group comprising Abraxane (Paclitaxel Albumin-stabilized Nanoparticle Formulation), Adriamycin (Doxorubicin Hydrochloride), Aducanumab (Aducanumab), Aldara (Imiquimod), Alemtuzumab, Alimta (Pemetrexed Disodium), Aminolevulinic Acid, Anastrozole, Aprepitant, Arimidex (Anastrozole), Aromasin (Exemestane), Arranon (Nelarabine), Arsenic Trioxide, Avastin (Bevacizumab), Azacitidine, Bevacizumab, Bexarotene, Bortezomib, Campath (Alemtuzumab), Camptosar (Irinotecan Hydrochloride), Capecitabine, Carboplatin, Cetuximab, Cisplatin, Clafen (Cyclophosphamide), Clofarabine, Clofarabine (Clofarabine), Clolar (Clofarabine), Cyclophosphamide, Cytarabine, Cytosar-U (Cytarabine), Cytoxan (Cyclophosphamide), Dacogen (Decitabine), Dasatinib, Decitabine, DepoCyt (Liposomal Cytarabine), DepoFoam (Liposomal Cytarabine), Dexrazoxane Hydrochloride, Docetaxel, Doxil (Doxorubicin Hydrochloride Liposome), Doxorubicin Hydrochloride, Doxorubicin Hydrochloride Liposome, Dox-SL (Doxorubicin Hydrochloride Liposome), Efudex (Fluorouracil), Ellence (Epirubicin Hydrochloride), Eloxatin (Ox-

aliplatin), Emend (Aprepitant), Epirubicin Hydrochloride, Erbitux (Cetuximab), Erlotinib Hydrochloride, Evacet (Doxorubicin Hydrochloride Liposome), Evista (Raloxifene Hydrochloride), Exemestane, Faslodex (Fulvestrant), Femara (Letrozole), Fluoroplex (Fluorouracil), Fluorouracil, Fulvestrant, Gefitinib, Gemcitabine Hydrochloride, Gemtuzumab Ozogamicin, Gemzar (Gemcitabine Hydrochloride), Gleevec (Imatinib Mesylate), Herceptin (Trastuzumab), Hycamtin (Topotecan Hydrochloride), Imatinib Mesylate, Imiquimod, Iressa (Gefitinib), Irinotecan Hydrochloride, Ixabepilone, Ixempra (Ixabepilone), Keoxifene (Raloxifene Hydrochloride), Kepivance (Palifermin), Lapatinib Ditosylate, Lenalidomide, Letrozole, Levulan (Aminolevulinic Acid), LipoDox (Doxorubicin Hydrochloride Liposome), Liposomal Cytarabine, Methazolastone (Temozolomide), Methotrexate, Mylosar (Azacitidine), Mylotarg (Gemtuzumab Ozogamicin), Nanoparticle Paclitaxel (Paclitaxel Albumin-stabilized Nanoparticle Formulation), Nelarabine, Neosar (Cyclophosphamide), Nexavar (Sorafenib Tosylate), Nilotinib, Nolvadex (Tamoxifen Citrate), Oncaspar (Pegaspargase), Oxaliplatin, Paclitaxel, Paclitaxel Albumin-stabilized Nanoparticle Formulation, Palifermin, Panitumumab, Paraplat (Carboplatin), Paraplatin (Carboplatin), Pegaspargase, Pemetrexed Disodium, Platinol-AQ (Cisplatin), Platinol (Cisplatin), Raloxifene Hydrochloride, Revlimid (Lenalidomide), Rituxan (Rituximab), Rituximab, Sclerosol Intrapleural Aerosol (Talc), Sorafenib Tosylate, Sprycel (Dasatinib), Sterile Talc Powder (Talc), Steritalc (Talc), Sunitinib Malate, Sutent (Sunitinib Malate), Synovir (Thalidomide), Talc, Tamoxifen Citrate, Tarabine PFS (Cytarabine), Tarceva (Erlotinib Hydrochloride), Targretin (Bexarotene), Tasigna (Nilotinib), Taxol (Paclitaxel), Taxotere (Docetaxel), Temozar (Temozolomide), Temozolomide, Temsirolimus, Thalomid (Thalidomide), Thalidomide, Totecl (Dexrazoxane Hydrochloride), Topotecan Hydrochloride, Torisel (Temsirolimus), Trastuzumab, Trisenox (Arsenic Trioxide), Tykerb (Lapatinib Ditosylate), Vectibix (Panitumumab), Velcade (Bortezomib), Vidaza (Azacitidine), Vorinostat, Xeloda (Capecitabine), Zinecard (Dexrazoxane Hydrochloride), Zoledronic Acid, Zolanza (Vorinostat) and Zometa (Zoledronic Acid).

According to a preferred embodiment of the invention the compound useful in the treatment of bone mass decrease is a bisphosphonate, a selective oestrogen receptor modulators (SERMs), a parathyroid hormone (PTH) (e.g. teriparatide (Forteo)), strontium ranelate, Denosumab or calcitonin, or a combination thereof. According to a more preferred embodiment, the bisphosphonate is chosen from the group comprising Alendronate (Fosamax, Fosamax Plus D), Etidronate (Didronel), Ibandronate (Boniva), Pamidronate (Aredia), Risedronate (Actonel, Actonel W/Calcium), Tiludronate (Skelid), and Zoledronic acid (Reclast, Zometa). According to a more preferred embodiment, the SERMs is chosen from the group comprising raloxifene (Evista), bazedoxifene/premarin (Aprel) and tamoxifen.

According to another embodiment, the present invention relates to the use of the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention for the treatment of diseases associated to an increased osteoclast activity. Such disease comprised but are not limited to endocrinopathies (hypercortisolism, hypogonadism, primary or secondary hyperparathyroidism, hyperthyroidism), hypercalcemia, deficiency states (rickets/osteomalacia, scurvy, malnutrition), chronic diseases (malabsorption syndromes, chronic renal failure (renal osteodystrophy), chronic liver disease (hepatic osteodystrophy), drugs (glucocorticoids (glucocorti-

coid-induced osteoporosis), androgen deprivation therapy, aromatase inhibitor therapy, heparin, alcohol), and hereditary diseases (osteogenesis imperfecta, homocystinuria), osteoporosis, osteopetrosis, inflammation of bone associated with arthritis and rheumatoid arthritis, periodontal disease, fibrous dysplasia, and/or Paget's disease.

According to another embodiment, the present invention relates to the use of the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention for the treatment of diseases associated to inflammation and/or autoimmunity. Such diseases comprise but are not limited to seronegative spondyloarthropathy (psoriatic arthritis, ankylosing spondylitis, reiters syndrome, spondyloarthropathy associated with inflammatory bowel disease), prosthetic joint loosening, connective tissue diseases (juvenile rheumatoid arthritis, rheumatoid arthritis, systemic lupus erythematosus (SLE) and lupus nephritis, scleroderma, Sjogren's syndrome, mixed connective tissue disease, polymyositis, dermatomyositis), inflammatory bowel disease (e.g. Crohn's disease; ulcerative colitis), whipples disease, arthritis associated with granulomatous ileocolitis, inflammatory skin conditions (autoimmune bullous pemphigoid, autoimmune pemphigus vulgaris, eczema, dermatitis), inflammatory lung disease (alveolitis, pulmonary fibrosis, sarcoidosis, asthma, bronchitis, bronchiolitis obliterans), inflammatory renal disease (glomerulonephritis, renal allograft rejection, renal tubular inflammation), atherosclerosis, systemic vasculitis (temporal arteritis/giant cell arteritis, takayasu arteritis, polyarteritis nodosa, Kawasaki disease, Wegener's granulomatosis, churg strauss syndrome, microscopic polyangiitis, necrotising glomerulonephritis, henoch schonlein purpura, essential cryoglobulinaemic vasculitis and other small vessel vasculitis, Behcets disease), macrophage activation diseases (macrophage activation syndrome (MAS), adult onset stills disease, haemophagocytic syndrome), polymyalgia rheumatica, primary biliary sclerosis, sclerosing cholangitis, autoimmune hepatitis, Type 1 Diabetes Mellitus, Hashimoto's thyroiditis, Graves' disease, multiple sclerosis (MS), Guillain-Barre syndrome, Addison's disease, and/or Raynaud's phenomenon, Goodpasture's syndrome.

According to another embodiment, the present invention relates to the use of the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention for the treatment of cancer.

As used herein, the term "cancer" refers but is not limited to adenocarcinoma, acinic cell adenocarcinoma, adrenal cortical carcinomas, alveoli cell carcinoma, anaplastic carcinoma, basaloid carcinoma, basal cell carcinoma, bronchiolar carcinoma, bronchogenic carcinoma, renaladinol carcinoma, embryonal carcinoma, anometroid carcinoma, fibrolamolar liver cell carcinoma, follicular carcinomas, giant cell carcinomas, hepatocellular carcinoma, intraepidermal carcinoma, intraepithelial carcinoma, leptomanigio carcinoma, medullary carcinoma, melanotic carcinoma, menigual carcinoma, mesometonephric carcinoma, oat cell carcinoma, squamal cell carcinoma, sweat gland carcinoma, transitional cell carcinoma, tubular cell carcinoma, amelioblastic sarcoma, angiolithic sarcoma, botryoid sarcoma, endometrial stroma sarcoma, ewing sarcoma, fascicular sarcoma, giant cell sarcoma, granulositic sarcoma, immunoblastic sarcoma, juxaccordial osteogenic sarcoma, coppices sarcoma, leukocytic sarcoma (leukemia), lymphatic sarcoma (lympho sarcoma), medullary sarcoma, myeloid sarcoma (granulocytic sarcoma), austiogeni sarcoma, periosteal sarcoma, reticulum cell sarcoma (histiocytic lymphoma), round cell sarcoma, spindle cell sarcoma, synovial sarcoma, telangiectatic audiogenic sarcoma,

Burkitt's lymphoma, NPD, NML, NH and diffuse lymphomas. According to a preferred embodiment, the method according to the invention is directed to the treatment of metastatic cancer to bone, wherein the metastatic cancer is breast, lung, renal, multiple myeloma, thyroid, prostate, adenocarcinoma, blood cell malignancies, including leukemia and lymphoma; head and neck cancers; gastrointestinal cancers, including esophageal cancer, stomach cancer, colon cancer, intestinal cancer, colorectal cancer, rectal cancer, pancreatic cancer, liver cancer, cancer of the bile duct or gall bladder; malignancies of the female genital tract, including ovarian carcinoma, uterine endometrial cancers, vaginal cancer, and cervical cancer; bladder cancer; brain cancer, including neuroblastoma; sarcoma, osteosarcoma; and skin cancer, including malignant melanoma or squamous cell cancer.

The present invention further concerns a method for improving the treatment of a cancer patient which is undergoing chemotherapeutic treatment with a cancer therapeutic agent, which comprises co-treatment of said patient along with a method as above disclosed.

The present invention further concerns a method of improving cytotoxic effectiveness of cytotoxic drugs or radiotherapy which comprises co-treating a patient in need of such treatment along with a method as above disclosed.

The present invention further concerns a method for improving the treatment of a patient with a disease associated to an increased osteoclast activity which is undergoing treatment with a biphosphonate, a selective oestrogen receptor modulators (SERMs), a parathyroid hormone (PTH) (e.g. teriparatide (Forteo)), strontium ranelate, Denosumab or calcitonin, or a combination thereof, which comprises co-treatment of said patient along with a method as above disclosed.

In another embodiment use of an antibody of the invention is contemplated in the manufacture of a medicament for preventing or treating metastatic cancer to bone in a patient suffering from metastatic cancer. In a related embodiment, the metastatic cancer is breast, lung, renal, multiple myeloma, thyroid, prostate, adenocarcinoma, blood cell malignancies, including leukemia or lymphoma; head or neck cancers; gastrointestinal cancers, including esophageal cancer, stomach cancer, colon cancer, intestinal cancer, colorectal cancer, rectal cancer, pancreatic cancer, liver cancer, cancer of the bile duct or gall bladder; malignancies of the female genital tract, including ovarian carcinoma, uterine endometrial cancers, vaginal cancer, or cervical cancer; bladder cancer; brain cancer, including neuroblastoma; sarcoma, osteosarcoma; or skin cancer, including malignant melanoma or squamous cell cancer.

According to another embodiment, the present invention relates to the use of the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention in the manufacture of a medicament.

According to another embodiment, the present invention relates to the use of the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention in the manufacture of a medicament for treating a patient having cancer.

According to another embodiment, the present invention relates to the use of the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention in the manufacture of a medicament for treating a patient having a disease associated to an increased osteoclast activity.

According to another embodiment, the present invention relates to the use of the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts

according to the invention in the manufacture of a medication for treating a patient having an inflammatory disease, more specifically an inflammatory bowel disease.

According to another embodiment, the present invention relates to the use of the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention in the manufacture of a medication for treating a patient suffering from rheumatoid arthritis.

Administering the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention may be accomplished by any means known to the skilled artisan. Preferred routes of administration include but are not limited to intradermal, subcutaneous, oral, parenteral, intramuscular, intranasal, sublingual, intratracheal, inhalation, ocular, vaginal, and rectal. According to a preferred embodiment the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention are delivered systemically.

The administration may take place in a single dose or a dose repeated one or several times after a certain time interval. Desirably, the antibody, the nucleic acid sequence, the vector, the pharmaceutical composition or the kit of parts according to the invention are administered 1 to 10 times at weekly intervals.

For general guidance, suitable dosage for the antibody is about 2 mg/kg to 30 mg/kg, 0.1 mg/kg to 30 mg/kg or 0.1 mg/kg to 10 mg/kg body weight. Suitable dosage for the vector according to the invention varies from about 10^4 to 10^{10} pfu (plaque forming units), desirably from about 10^5 and 10^8 pfu for MVA vector whereas it varies from about 10^5 to 10^{13} iu (infectious units), desirably from about 10^7 and 10^{12} iu for adenovirus based vector. A composition based on vector plasmids may be administered in doses of between 10 µg and 20 mg, advantageously between 100 µg and 2 mg.

When the use or the method according to the invention is for the treatment of cancer, the method or use of the invention can be carried out in conjunction with one or more conventional therapeutic modalities (e.g. radiation, chemotherapy and/or surgery). The use of multiple therapeutic approaches provides the patient with a broader based intervention. In one embodiment, the method of the invention can be preceded or followed by a surgical intervention. In another embodiment, it can be preceded or followed by radiotherapy (e.g. gamma radiation). Those skilled in the art can readily formulate appropriate radiation therapy protocols and parameters which can be used (see for example PEREZ, Principles and practice of radiation oncology. 2nd edition. LIPPINCOTT, 1992.)

BRIEF DESCRIPTION OF FIGURES IN THE DRAWINGS

FIG. 1 depicts the specific staining of CSF-1R-transfected NIH/3T3 cells by mAb CXIIG6.

FIG. 2 shows the inhibition of CSF-1 binding to cell-surface CSF-1R in presence of mAb CXIIG6.

FIG. 3 shows the specific blockade of soluble human CSF-1R by mAb CXIIG6 ('ctrl' means control; 'neg SN' means negative control hybridoma supernatant).

FIG. 4 shows the inhibition of human osteoclast differentiation and secretion of matrix-metalloprotease-9 (MMP-9) in presence of mAb CXIIG6 ('ctrl' means control; 'CXIIG6 SN' means CXIIG6 hybridoma supernatant; 'neg SN' means negative control hybridoma supernatant).

FIG. 5 shows the non-cross-reactivity of mAb CXIIG6 with other tyrosine kinase receptors having homology to CSF-1R ('SN' means hybridoma supernatant).

FIG. 6 shows the nucleic acid sequence (SEQ ID NO: 1) and deduced amino acid sequence (SEQ ID NO: 2) of the CXIIG6 heavy chain. The primer sequences including restriction sites for cloning added to the nucleotide sequences are underlined. The restriction sites are shown in underlined italic type. The amino acid sequences of the V-domains are highlighted in bold type.

FIG. 7 shows the nucleic acid sequence (SEQ ID NO: 3) and deduced amino acid sequence (SEQ ID NO: 4) of the CXIIG6 light chain. The primer sequences including restriction sites for cloning added to the nucleotide sequences are underlined. The restriction sites are shown in underlined italic type. The amino acid sequences of the V-domains are highlighted in bold type.

FIG. 8 shows the plasmid construct pTG17753.

FIG. 9 shows the plasmid construct pTG17727.

FIG. 10 shows the plasmid construct pOptiVEC™.

FIG. 11 shows the plasmid construct pTG17895.

FIG. 12 shows the plasmid construct pTG17812.

FIG. 13 shows the plasmid construct pTG17868.

FIG. 14 shows the plasmid construct pTG17869.

FIG. 15 shows humanized CXIIG6 light chain variants.

FIG. 16 shows humanized CXIIG6 IgG1 heavy chain variants.

FIG. 17 shows the specific blockade of soluble human CSF-1R by recombinant murine CXIIG6 and chimeric CXIIG6 IgG1.

FIG. 18 shows, the inhibition of human osteoclast differentiation and secretion of matrix-metalloprotease-9 (MMP-9) in presence of recombinant murine CXIIG6 and chimeric CXIIG6 IgG1.

MODE(S) FOR CARRYING OUT THE INVENTION

Specific Staining of CSF-1R-Transfected NIH/3T3 Cells by mAb CXIIG6

The B4-800-5 cell line was generated by stable transfection of NIH/3T3 cells with an expression plasmid encoding the full-length human CSF-1R. Cell-surface CSF-1R expression on B4-800-5 cells was verified by indirect immunostaining with the anti-human CSF-1R mAbs 61701 (mouse IgG₁, R&D Systems) or 2-4A5-4 (rat IgG_{1,k}, GeneTex), compared to isotype controls (FIG. 1, upper and middle panels). Culture supernatants from hybridoma CXIIG6 or from a negative control hybridoma were used for immunostaining B4-800-5 cells or parental NIH/3T3 cells (FIG. 1, lower panels).

Flow cytometry analysis showed that culture supernatant from hybridoma CXIIG6 selectively stained B4-800-5 cells, demonstrating the mAb specificity for cell-surface CSF-1R.

Inhibition of CSF-1 Binding to Cell-Surface CSF-1R

3×10^5 THP-1 cells (human CSF-1R-positive monocytic leukemia cell line) were incubated for 30 min at 4° C. in the presence of either hybridoma culture supernatants, serum from a naive or an anti-CSF-1R-immunized mouse (dilution 1:1000), mAb anti-CSF-1R 2-4A5-4 (GeneTex) or a control rat IgG₁ (10 µg/ml), or no reagent. After two washes with cold PBS, cells were incubated with 1 µg/ml biotinylated recombinant human CSF-1 for 30 min. Cells were washed twice and further incubated for 30 min at 4° C. with 10 µg/ml strepta-

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vidin-Alexa Fluor 488 (Invitrogen). After washing with PBS and fixation with 4% paraformaldehyde, cell staining was analyzed by flow cytometry.

Decreased fluorescence intensities compared to control samples reflect the inhibition of CSF-1 binding to cell-surface CSF-1R. Serum from a CSF-1R-immunized mouse blocks CSF-1 binding to THP-1 cells (FIG. 2). While negative control hybridoma supernatant or an irrelevant mAb show no effect, culture supernatant from hybridoma CXIIG6 inhibits CSF-1 binding to THP-1 cells (FIG. 2, lower right panel), as does mAb 2-4A5-4 (lower left panel).

Localization of mAb CXIIG6 Binding Site

To identify the binding site of mAb CXIIG6 on the CSF-1R, a Western blot was performed using soluble forms of the human CSF-1R comprising either the five extracellular immunoglobulin-like domains (Met 1 to Glu 512, R&D Systems) or only the three N-terminal immunoglobulin-like domains of the extracellular region of CSF-1R (Met 1 to Ser 290), both fused at their C-terminal ends to the Fc region of a human IgG₁. A soluble form of the EGFR fused to human IgG₁ Fc (R&D Systems) was used as a negative control.

Hundred nanograms of each soluble receptor were submitted to electrophoresis in native conditions before transfer to nitrocellulose sheet and probing with either hybridoma supernatants, rabbit pAb c-fms/CSF-1R H300 (Santa Cruz Biotechnology), mouse mAb 61701 (R&D Systems) or serum from naive or CSF-1R-immunized mice.

Both soluble forms of the CSF-1R were detected as broad bands when probed with pAb c-fms/CSF-1R H300, mAb 61701 or serum from the immunized mouse. No detectable signals were observed with naive mouse serum or a negative control hybridoma supernatant. CXIIG6 hybridoma supernatant recognized CSF-1R₁₋₂₉₀:Fc as well as CSF-1R₁₋₅₁₂:Fc, but not EGFR:Fc, indicating that CXIIG6 binds specifically to an epitope lying within the three N-terminal immunoglobulin-like domains (between residues 1 to 290) of the human CSF-1R.

Specific Blockade of Soluble Human CSF-1R by mAb CXIIG6

The CSF-1-dependent murine myeloid leukemia M-NFS-60 cell line (#CRL-1838, ATCC) was used to assess the blocking activity of CXIIG6 hybridoma supernatant on human and murine CSF-1R. Five nanograms of soluble human CSF-1R (CSF-1R₁₋₅₁₂:Fc from R&D Systems) were preincubated in white 96-well microplates with serial dilutions of either hybridoma supernatants, mAb 61701 (R&D Systems) or murine isotype control mAb. 10E4 M-NFS-60 cells cultured overnight in the absence of CSF-1 were then added into the culture wells together with 0.1 ng of human CSF-1 in a final assay volume of 100 µl. Cultures were incubated for 48 h at 37° C. and proliferation was quantified by BrdU incorporation using a Cell Proliferation ELISA (Roche).

Soluble human CSF-1R completely inhibited the proliferation of M-NFS-60 cells mediated by human CSF-1, as shown in the presence of negative hybridoma supernatant containing or not a negative control IgG₁ (FIG. 3; mean±SEM of 3 wells). In contrast, CXIIG6 hybridoma supernatant and positive control mAb 61701 were both able to restore cell proliferation in a dose-dependent manner, showing that they were able to neutralize soluble human CSF-1R.

In this assay, active M-NFS-60 cell proliferation in the presence of low dilutions of CXIIG6 hybridoma supernatant

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showed that mAb CXIIG6 was unable to block the murine CSF-1R expressed by M-NFS-60 cells. Moreover, in a murine CSF-1-supported M-NFS-60 proliferation assay performed in the absence of soluble CSF-1R, treatment with mAb AFS98 anti-mouse CSF-1R (eBioscience) resulted in a dramatic concentration-dependent decrease of cell growth (data not shown). CXIIG6 hybridoma supernatant, like negative control antibodies and negative hybridoma supernatant, caused no reduction in cell proliferation. These results demonstrate that mAb CXIIG6 specifically targets human CSF-1R.

Inhibition of Human Osteoclast Differentiation and Secretion of Matrix-Metalloprotease-9 (MMP-9)

Osteoclasts, were generated from human monocytes obtained by elutriation of PBMCs from a healthy blood donor. In brief, monocytes were seeded at 2×10E4 cells per well in 96-well plates and treated for 45 min with either hybridoma culture supernatants, mAbs anti-human CSF-1R 61701 (R&D Systems) or 2-4A5-4 (GeneTex), mAb anti-human CSF-1 26730 (R&D Systems), murine or rat isotype controls, or sera from naive and CSF-1R-immunized mice diluted in hybridoma culture medium. Complete a-MEM medium was added to the culture wells with or without human CSF-1 and RANKL (PeproTech, 25 and 40 ng/ml respectively). Hybridoma supernatants, mAbs or/and medium with or without cytokines were replenished every 3 days for 9 days. Conditioned culture supernatants were harvested on day 9 and assayed for total human MMP-9 using an ELISA assay (R&D Systems). Osteoclast formation was evaluated by staining of tartrate-resistant acid phosphatase (TRAP) using the leukocyte acid phosphatase kit from Sigma-Aldrich.

CSF-1+RANKL induced monocytes to differentiate into osteoclasts, defined as large multinucleated TRAP-positive cells, whereas no TRAP-positive osteoclasts were obtained in the absence of cytokines. Addition of 0.5 µg/ml anti-CSF-1 mAb 26730 completely abrogated osteoclast differentiation, as shown by lack of MMP-9 secretion. Anti-CSF-1R mAbs 61701 or 2-4A5-4 at the same concentration and immunized mouse serum (dilution 1:1000) inhibited osteoclast formation only partially (FIG. 4; with (+) or without (−) cytokines; mean±SEM of 3 wells; *: mean of 2 wells). Treatment with CXIIG6 hybridoma culture supernatant diluted 1:20 or 1:100 significantly reduced the level of MMP-9 production, compared with two negative control hybridoma supernatants (A, B). These results demonstrate that mAb CXIIG6 inhibits the differentiation of osteoclasts from human monocytes by blocking the function of cell surface CSF-1R.

Inhibition of the CSF-1-Dependent Phosphorylation of CSF-1R

The B4-800-5 cell line obtained by stable transfection of NIH/3T3 cells with a plasmid expressing human CSF-1R was used to investigate the effect of CXIIG6 hybridoma supernatant on CSF-1-dependent CSF-1R phosphorylation. Cells were seeded at 2×10E5 cells per 60-mm Petri dish and cultured for 48 to 72 h. Following serum deprivation for 1 h at 37° C., cells were treated for 1 h at 37° C. with culture medium containing either CXIIG6 hybridoma supernatant, mAb 2-4A5-4 (NeoMarkers) or isotype control mAbs (diluted in negative hybridoma supernatant), and then stimulated with 100 ng/ml hCSF-1 or left unstimulated for 5 min at 37° C. Cell layers were then lysed and total proteins were extracted. Ten µg proteins were analyzed by probing Western

blots with either the rabbit pAb c-fms/CSF-1R H300 or the rabbit pAb p-c-fms/CSF-1R (Tyr708)-R (Santa Cruz Biotechnology), followed by goat anti-rabbit immunoglobulin-sHRP.

In the absence of CSF-1, neither CXIIIG6 hybridoma supernatant nor mAb 2-4A5-4 induced receptor phosphorylation as seen with the antibody specific for CSF-1R phosphorylated at position 708, showing that mAb CXIIIG6 alone does not exert an agonistic effect. Upon stimulation with CSF-1, the amount of CSF-1R decreased in isotype control-treated cells compared with unstimulated cells, and CSF-1R was phosphorylated on Tyr708 (data not shown). Pretreatment with CXIIIG6 hybridoma supernatant or with mAb 2-4A5-4 did not enhance CSF-1R disappearance. Phosphorylation of CSF-1R was decreased following treatment with CXIIIG6 hybridoma supernatant or with mAb 2-4A5-4. These results show that mAb CXIIIG6 is able to block the CSF-1-dependent phosphorylation of CSF-1R.

Cross-Reactivity of mAb CXIIIG6

The cross-reactivity of mAb CXIIIG6 was tested by ELISA on a series of purified soluble receptors belonging to the type III subfamily of tyrosine kinase receptors and showing homology to CSF-1R in their extracellular Ig-like domains: soluble VEGFR-1, VEGFR-2, Flt-3 and PDGFR β (all four expressed as Fc fusion proteins), as well as PDGFR α and SCFR (c-kit) were obtained from R&D Systems and used for coating an ELISA plate. Soluble EGFR(R&D Systems), from the EGFR subfamily of tyrosine kinase receptors, was used as a negative control.

Culture supernatants from either hybridoma CXIIIG6 (CXIIIG6 SN) or a negative control hybridoma, or the anti-CSF-1R mouse IgG₁ 61701 (R&D Systems) were incubated on the coated ELISA plate at antibody concentrations of 500 ng/ml. After washing the ELISA plate, bound antibodies were revealed using peroxidase-conjugated goat anti-mouse Ig (Sigma) and OD_(450-540 nm) was measured. Results depicted in FIG. 5 show that like mAb 61701, CXIIIG6 strongly bound the CSF-1R while no specific signal was detected on any other tyrosine kinase receptor. This shows that among the various type III tyrosine kinase receptors tested, CXIIIG6 is specific for CSF-1R.

Construction of Expression Vectors for mAb CXIIIG6

The OptiCHO™ Antibody Express Kit (Invitrogen, Catalog No. 12762-019) was used for the cloning of the genes encoding the CXIIIG6 heavy and light chains in order to produce the mAb CXIIIG6 in DG44 mammalian cell line. The OptiCHO™ Antibody Express Kit includes: (1) The pOptiVEC™ vector, a bicistronic plasmid that allows the cloning of the gene of interest downstream of CMV promoter. The transcription of the gene of interest is separated from the dihydrofolate reductase (DHFR) auxotrophic selection marker by an internal ribosome entry site (IRES), allowing transcription of the gene of interest and of the selection marker on the same mRNA; (2) The pcDNA™ 3.3 vector that allows the cloning of the gene of interest downstream of CMV promoter. The pcDNA™ 3.3 contains a neomycin resistance gene allowing selection using Geneticin®. The pOptiVEC™ and pcDNA™ 3.3 vectors contain the TK poly-A sequence which directs proper processing of the 3' end of the mRNA of the gene of interest.

Specific primers (see Table 4) were synthesized and used for the PCR amplification and cloning of the entire CXIIIG6 heavy chain and light chain genes (respectively SEQ ID NO:1

and SEQ ID NO:3; see respectively FIG. 6 and FIG. 7). The backward primers included the Kozak consensus sequence for efficient eukaryotic translation (KOZAK M. An analysis of 5'-noncoding sequences from 699 vertebrate messenger RNAs. *Nucleic Acids Res.* 1987, 15(20): 8125-8148.).

TABLE 4

Primer	Sequence
OTG18929	GCCGCCACCATGTACTTGGGACTGAACATATGTATTC (SEQ ID NO: 30)
OTG18930	GGAGATCTTCATTACCCGGAGTCCGGGA (SEQ ID NO: 31)
OTG18931	GCCGCCACCATGAGTGTGCCACTCAGGTCCTG (SEQ ID NO: 32)
OTG18932	GCCCGGGCTAACACTCATTCTGTGAAGCTC (SEQ ID NO: 33)

CXIIIG6 heavy chain was PCR amplified by using OTG18929 and OTG18930 with plasmid pTG17753 (FIG. 8) as template, and cloned into the vector pOptiVEC™-TOPO® (pOptiVEC™-TOPO® TA Cloning® Kit, Invitrogen, Catalog no. 12744-017-01) and the pcDNA™ 3.3-TOPO® vectors (pcDNA™ 3.3-TOPO® TA Cloning® Kit, Invitrogen, Catalog No. K8300-01) to obtain respectively pTG17786 and pTG17789.

CXIIIG6 light chain was PCR amplified by using OTG18931 and OTG18932 with plasmid pTG17727 (FIG. 9) as template, and cloned into the vector pOptiVEC™-TOPO® (pOptiVEC™-TOPO® TA Cloning® Kit, Invitrogen, Catalog no. 12744-017-01) and the pcDNA™ 3.3-TOPO® vectors (pcDNA™ 3.3-TOPO® TA Cloning® Kit, Invitrogen, Catalog No. K8300-01) to obtain respectively pTG17788 and pTG17787.

The nucleotide sequence of the whole expression cassette, including CMV promoter and TK polyA signal of pTG17786, pTG17787, pTG17788 and pTG17789 were sequenced and found in compliance with their theoretical sequences.

Generation of Chimeric Antibodies from mAb CXIIIG6

The variable domains of mAb CXIIIG6 were combined with human constant regions.

To generate the chimeric light chain (named Chimeric CXIIIG6 Iv chain), a theoretical sequence was designed by joining the sequence encoding the CXIIIG6 VK Domain (from SEQ ID NO:3) to the sequence encoding for the human IGKC region (GenBank accession number: J00241). This XbaI NotI DNA fragment kept the same non translated sequence at 5' end, including Kozak sequence, as the one used in the murine version (as in pTG17787 and pTG17788 described above). The chimeric CXIIIG6 light chain sequence was codon optimized for expression in CHO, assembled from synthetic oligonucleotides, and subcloned into pOptiVEC™ (FIG. 10) via XbaI NotI by GeneArt AG. The obtained chimeric CXIIIG6 light chain (variable and constant regions) codon optimized nucleic acid sequence is as set forth in SEQ ID NO:34. The obtained plasmid was named pTG17895 (FIG. 11).

To generate the chimeric heavy IgG1 and IgG4 chains (respectively named Chimeric CXIIIG6 IgG1 and Chimeric CXIIIG6 IgG4 chains), the theoretical sequences were designed by joining the sequence encoding the CXIIIG6 VH Domain (from SEQ ID NO:1) to the sequences encoding either for the human IGHG1C region (GenBank accession number:

J00228) or for the human IGHG4C region (GenBank accession number: K01316). These XbaI NotI DNA fragments kept the same non translated sequence at 5' end, including Kozak sequence, as the one used in the murine version (as in pTG17786 and pTG17789 as described above). The chimeric CXIIG6 heavy chains were then codon optimized for expression in CHO, synthesized and cloned into pTG17812 (FIG. 12) via XbaI NotI by GeneArt AG. The obtained chimeric CXIIG6 IgG1 heavy chain (variable and constant regions) codon optimized nucleic acid sequence is as set forth in SEQ ID NO:35 and the obtained plasmids was named pTG17868 (FIG. 13). The obtained chimeric CXIIG6 IgG4 heavy chain (variable and constant regions) codon optimized nucleic acid sequence is as set forth in SEQ ID NO:36 and the obtained plasmids was named pTG17869 (FIG. 14).

Generation of Human Antibodies from mAb CXIIG6

To generate the humanized light chain variants, amino acid substitutions according to Table 2 were performed within the light-chain variable region as set forth in SEQ ID NO:9.

DNA sequences were designed by joining modified sequences bearing substitutions of the CXIIG6 VK Domain (from SEQ ID NO:3) to the sequence encoding for the human IGKC region (GenBank accession number: J00241). This XbaI NotI DNA fragment kept the same non translated sequence at 5' end including Kozak sequence as the one used in the murine version (as in pTG17787 and pTG17788 as described above). The humanized CXIIG6 light chain sequences were then codon optimized for expression in CHO, assembled from synthetic oligonucleotides and cloned into pOptiVEC™ (FIG. 10) via XbaI NotI by GeneArt AG. The obtained humanized CXIIG6 light chain variants and plasmids are listed in FIG. 15.

To generate the humanized heavy chain variants, amino acid substitutions according to Table 1 were performed within the heavy-chain variable region as set forth in SEQ ID NO:6.

DNA sequences were designed by joining modified sequences bearing substitutions of the CXIIG6 VH Domain (from SEQ ID NO:1) to the sequences encoding for the human IGHG1C region (GenBank accession number: J00228). The XbaI ApaI DNA fragments kept the same non translated sequence at 5' end including Kozak sequence as used the one in the murine version (as in pTG17786 and pTG17789 as described above). The DNA sequences were then codon optimized for expression in CHO, synthesized and cloned into pTG17812 (FIG. 12) via XbaI ApaI by GeneArt AG. The obtained humanized CXIIG6 IgG1 heavy chain variants and plasmids are listed in FIG. 16.

In Vitro Inhibitory Activities of Recombinant Murine CXIIG6 and Chimeric CXIIG6 IgG1

To determine whether purified recombinant murine CXIIG6 (as previously described) and its chimeric IgG1 variant (chimeric CXIIG6 IgG1 as previously described) were able to block soluble human CSF-1R, dose-response studies were performed in the M-NFS-60 cell proliferation and osteoclast differentiation models (as previously described). Purified polyclonal murine IgG2a from Rockland (Rockland, 010-0141) and a chimeric IgG1 produced by the applicant were tested in parallel as control antibodies. Blocking effect was evaluated by exposing cells to concentration ranges of active anti-CSF-1R antibodies, as measured by antigen binding in a SPR biosensor assay. Comparison between mAbs

CXIIG6 and their respective control mAb was done by loading equal amounts of total antibody (SPR biosensor assay by Fc binding).

M-NFS-60 bioassay: In the M-NFS-60 bioassay, cells were treated with 0.23 ng/ml to 0.5 µg/ml active mAbs CXIIG6 (recombinant murine CXIIG6; chimeric CXIIG6 IgG1) or corresponding concentrations of control mAbs in the presence of 50 ng/ml human soluble CSF-1R and 1 ng/ml human CSF-1 for 48 h. Results depicted in FIG. 17 show that M-NFS-60 cell growth increased in response to increasing concentrations of both mAbs CXIIG6 (recombinant murine CXIIG6; chimeric CXIIG6 IgG1) demonstrating that they antagonized the binding of soluble CSF-1R to CSF-1 (mean+/-SEM of triplicate wells). Chimeric CXIIG6 IgG1 was as effective as recombinant murine CXIIG6 in restoring cell proliferation. Control murine IgG2a and chimeric IgG1 had no effect on CSF-1 neutralization by soluble CSF-1R over their respective concentration range.

Osteoclast bioassay: In the osteoclast bioassay, elutriated human monocytes were incubated for 8 days with 0.85 ng/ml to 0.62 µg/ml active mAbs CXIIG6 (recombinant murine CXIIG6; chimeric CXIIG6 IgG1) in the presence of 25 ng/ml CSF-1 (ImmunoTools) and 40 ng/ml RANKL. The medium and all added agents were replenished on day 4 and 6 and total MMP-9 was measured in culture media conditioned from day 6 to 8. Results depicted in FIG. 18 show that in comparison with control antibodies, recombinant murine CXIIG6 and its chimeric variant (chimeric CXIIG6 IgG1) each significantly reduced MMP-9 production which parallels osteoclast differentiation, indicating that growth retardation occurred (FIG. 18; mean+/-SEM of triplicate wells).

Taken together, these results further demonstrate that purified recombinant murine CXIIG6 and chimeric CXIIG6 IgG1 inhibit cell-surface as well as soluble human CSF-1R.

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SEQUENCE LISTING

<160> NUMBER OF SEQ ID NOS: 36

<210> SEQ ID NO 1

<211> LENGTH: 1404

<212> TYPE: DNA

<213> ORGANISM: Mus musculus

<400> SEQUENCE: 1

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gtgaagcttg aggagtctgg aggaggttg gtgcagcctg gaggatccat gaaactctct      120
tgtgtgcct ctggattcac ttttagtgac gcctggatgg actgggtccg ccagtctcca      180
gagatgggac ttgagtgggt tgctgaaatt agaagcaaag ctaataatca tgcaacattc      240
tatgtcgtagt ctgtgaaagg gaggttcacc atctcaagag atgattccaa aagtagtgtc      300
tacctgcaaa tgaacagctt aagacctgaa gacactggca tttattactg taccagggta      360
aaggtaggct ttgacaactg gggccaaggc accactctca cagtctcttc agccaaaaca      420
acagcccat cgggtctatcc actggccctc gtgtgtggag atacaactgg ctctcgggtg      480
actctaggat gcctgggtcaa gggttatttc cctgagccag tgacctgac ctggaactct      540
ggatccctgt ccagtgggtg gcacaccttc ccagtgtcc tgcagtctga cctctacacc      600
ctcagcagct cagtgtactgt aacctcgagc acctggccca gccagtccat cacctgcaat      660
gtggcccacc cggcaagcag caccaagggt gacaagaaaa ttgagcccag agggcccaca      720
atcaagccct gtctctcatg caaatgccca gcacctaaac tcttgggtgg accatccgtc      780
ttcatcttcc ctccaaagat caaggatgta ctcatgatct ccctgagccc catagtcaca      840
tgtgtggtgg tggatgtgag cgaggatgac ccagatgtcc agatcagctg gtttgtgaac      900
aacgtggaag tacacacagc tcagacacaa acccatagag aggattacaa cagtactctc      960
cgggtggtca gtgccctccc catccagcac caggactgga tgagtggcaa ggagtcaaa     1020
tgcaaggtea acaacaaaga cctcccagcg cccatcgaga gaacctctc aaaacccaaa     1080
gggtcagtaa gagctccaca ggtatatgtc ttgcctccac cagaagaaga gatgactaag     1140
aaacaggtea ctctgacctg catggtcaca gacttcatgc ctgaagacat ttacgtggag     1200
tggaccaaca acgggaaaac agagctaaac tacaagaaca ctgaaccagt cctggactct     1260
gatggttctt acttcatgta cagcaagctg agagtggaaa agaagaactg ggtggaaaga     1320
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<210> SEQ ID NO 2

<211> LENGTH: 467

<212> TYPE: PRT

<213> ORGANISM: mus musculus

<400> SEQUENCE: 2

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Met Tyr Leu Gly Leu Asn Tyr Val Phe Ile Val Phe Leu Leu Asn Gly
1           5           10          15

Val Gln Ser Glu Val Lys Leu Glu Ser Gly Gly Gly Leu Val Gln
20          25          30

Pro Gly Gly Ser Met Lys Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe
35          40          45

Ser Asp Ala Trp Met Asp Trp Val Arg Gln Ser Pro Glu Met Gly Leu
50          55          60

Glu Trp Val Ala Glu Ile Arg Ser Lys Ala Asn Asn His Ala Thr Phe

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65	70	75	80
Tyr Ala Glu Ser Val Lys Gly Arg Phe Thr Ile Ser Arg Asp Asp Ser	85	90	95
Lys Ser Ser Val Tyr Leu Gln Met Asn Ser Leu Arg Pro Glu Asp Thr	100	105	110
Gly Ile Tyr Tyr Cys Thr Arg Val Lys Val Gly Phe Asp Asn Trp Gly	115	120	125
Gln Gly Thr Thr Leu Thr Val Ser Ser Ala Lys Thr Thr Ala Pro Ser	130	135	140
Val Tyr Pro Leu Ala Pro Val Cys Gly Asp Thr Thr Gly Ser Ser Val	145	150	155
Thr Leu Gly Cys Leu Val Lys Gly Tyr Phe Pro Glu Pro Val Thr Leu	165	170	175
Thr Trp Asn Ser Gly Ser Leu Ser Ser Gly Val His Thr Phe Pro Ala	180	185	190
Val Leu Gln Ser Asp Leu Tyr Thr Leu Ser Ser Ser Val Thr Val Thr	195	200	205
Ser Ser Thr Trp Pro Ser Gln Ser Ile Thr Cys Asn Val Ala His Pro	210	215	220
Ala Ser Ser Thr Lys Val Asp Lys Lys Ile Glu Pro Arg Gly Pro Thr	225	230	235
Ile Lys Pro Cys Pro Pro Cys Lys Cys Pro Ala Pro Asn Leu Leu Gly	245	250	255
Gly Pro Ser Val Phe Ile Phe Pro Pro Lys Ile Lys Asp Val Leu Met	260	265	270
Ile Ser Leu Ser Pro Ile Val Thr Cys Val Val Val Asp Val Ser Glu	275	280	285
Asp Asp Pro Asp Val Gln Ile Ser Trp Phe Val Asn Asn Val Glu Val	290	295	300
His Thr Ala Gln Thr Gln Thr His Arg Glu Asp Tyr Asn Ser Thr Leu	305	310	315
Arg Val Val Ser Ala Leu Pro Ile Gln His Gln Asp Trp Met Ser Gly	325	330	335
Lys Glu Phe Lys Cys Lys Val Asn Asn Lys Asp Leu Pro Ala Pro Ile	340	345	350
Glu Arg Thr Ile Ser Lys Pro Lys Gly Ser Val Arg Ala Pro Gln Val	355	360	365
Tyr Val Leu Pro Pro Pro Glu Glu Glu Met Thr Lys Lys Gln Val Thr	370	375	380
Leu Thr Cys Met Val Thr Asp Phe Met Pro Glu Asp Ile Tyr Val Glu	385	390	395
Trp Thr Asn Asn Gly Lys Thr Glu Leu Asn Tyr Lys Asn Thr Glu Pro	405	410	415
Val Leu Asp Ser Asp Gly Ser Tyr Phe Met Tyr Ser Lys Leu Arg Val	420	425	430
Glu Lys Lys Asn Trp Val Glu Arg Asn Ser Tyr Ser Cys Ser Val Val	435	440	445
His Glu Gly Leu His Asn His His Thr Thr Lys Ser Phe Ser Arg Thr	450	455	460
Pro Gly Lys			
465			

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<211> LENGTH: 705
 <212> TYPE: DNA
 <213> ORGANISM: Mus musculus

<400> SEQUENCE: 3

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gacatccaga tgactcagtc tccagcctcc ctatctgtat ctgtgggaga aactgtcacc    120
atcacatgtc gagcaagtga gaatatttac agtaatttag catggtatca gcagaaacag    180
ggaaaatctc ctcagctcct ggtccatgct gcaacaaact tagcagatgg tgtgccatca    240
aggttcagtg gcagtggatc aggcacacag tattccctca agatcaacag cctgcagtct    300
gaagattttg ggagttatta ctgtcaacat ttttggggta ctctcggac gttcgggtga    360
ggcaccaagt tggaaatcaa acgggctgat gctgcaccaa ctgtatccat ctccccacca    420
tccagtgagc agttaacatc tggaggtgcc tcagtcgtgt gcttcttgaa caacttctac    480
cccaaagaca tcaatgtcaa gtggaagatt gatggcagtg aacgacaaaa tggcgtctctg    540
aacagttgga ctgatcagga cagcaaagac agcacctaca gcatgagcag caccctcacg    600
ttgaccaagg acgagtatga acgacataac agctatacct gtgaggccac tcacaagaca    660
tcaacttcac ccattgtcaa gagcttcaac aggaatgagt gttag                      705

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<210> SEQ ID NO 4
 <211> LENGTH: 234
 <212> TYPE: PRT
 <213> ORGANISM: mus musculus

<400> SEQUENCE: 4

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Met Ser Val Pro Thr Gln Val Leu Gly Leu Leu Leu Trp Leu Thr
1      5      10      15
Asp Ala Arg Cys Asp Ile Gln Met Thr Gln Ser Pro Ala Ser Leu Ser
20     25     30
Val Ser Val Gly Glu Thr Val Thr Ile Thr Cys Arg Ala Ser Glu Asn
35     40     45
Ile Tyr Ser Asn Leu Ala Trp Tyr Gln Gln Lys Gln Gly Lys Ser Pro
50     55     60
Gln Leu Leu Val His Ala Ala Thr Asn Leu Ala Asp Gly Val Pro Ser
65     70     75     80
Arg Phe Ser Gly Ser Gly Ser Gly Thr Gln Tyr Ser Leu Lys Ile Asn
85     90     95
Ser Leu Gln Ser Glu Asp Phe Gly Ser Tyr Tyr Cys Gln His Phe Trp
100    105    110
Gly Thr Pro Arg Thr Phe Gly Gly Gly Thr Lys Leu Glu Ile Lys Arg
115    120    125
Ala Asp Ala Ala Pro Thr Val Ser Ile Phe Pro Pro Ser Ser Glu Gln
130    135    140
Leu Thr Ser Gly Gly Ala Ser Val Val Cys Phe Leu Asn Asn Phe Tyr
145    150    155    160
Pro Lys Asp Ile Asn Val Lys Trp Lys Ile Asp Gly Ser Glu Arg Gln
165    170    175
Asn Gly Val Leu Asn Ser Trp Thr Asp Gln Asp Ser Lys Asp Ser Thr
180    185    190
Tyr Ser Met Ser Ser Thr Leu Thr Leu Thr Lys Asp Glu Tyr Glu Arg
195    200    205
His Asn Ser Tyr Thr Cys Glu Ala Thr His Lys Thr Ser Thr Ser Pro
210    215    220

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Ile Val Lys Ser Phe Asn Arg Asn Glu Cys
225 230

<210> SEQ ID NO 5
<211> LENGTH: 19
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 5

Met Tyr Leu Gly Leu Asn Tyr Val Phe Ile Val Phe Leu Leu Asn Gly
1 5 10 15

Val Gln Ser

<210> SEQ ID NO 6
<211> LENGTH: 118
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 6

Glu Val Lys Leu Glu Glu Ser Gly Gly Gly Leu Val Gln Pro Gly Gly
1 5 10 15

Ser Met Lys Leu Ser Cys Ala Ala Ser Gly Phe Thr Phe Ser Asp Ala
20 25 30

Trp Met Asp Trp Val Arg Gln Ser Pro Glu Met Gly Leu Glu Trp Val
35 40 45

Ala Glu Ile Arg Ser Lys Ala Asn Asn His Ala Thr Phe Tyr Ala Glu
50 55 60

Ser Val Lys Gly Arg Phe Thr Ile Ser Arg Asp Asp Ser Lys Ser Ser
65 70 75 80

Val Tyr Leu Gln Met Asn Ser Leu Arg Pro Glu Asp Thr Gly Ile Tyr
85 90 95

Tyr Cys Thr Arg Val Lys Val Gly Phe Asp Asn Trp Gly Gln Gly Thr
100 105 110

Thr Leu Thr Val Ser Ser
115

<210> SEQ ID NO 7
<211> LENGTH: 330
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 7

Ala Lys Thr Thr Ala Pro Ser Val Tyr Pro Leu Ala Pro Val Cys Gly
1 5 10 15

Asp Thr Thr Gly Ser Ser Val Thr Leu Gly Cys Leu Val Lys Gly Tyr
20 25 30

Phe Pro Glu Pro Val Thr Leu Thr Trp Asn Ser Gly Ser Leu Ser Ser
35 40 45

Gly Val His Thr Phe Pro Ala Val Leu Gln Ser Asp Leu Tyr Thr Leu
50 55 60

Ser Ser Ser Val Thr Val Thr Ser Ser Thr Trp Pro Ser Gln Ser Ile
65 70 75 80

Thr Cys Asn Val Ala His Pro Ala Ser Ser Thr Lys Val Asp Lys Lys
85 90 95

Ile Glu Pro Arg Gly Pro Thr Ile Lys Pro Cys Pro Pro Cys Lys Cys
100 105 110

Pro Ala Pro Asn Leu Leu Gly Gly Pro Ser Val Phe Ile Phe Pro Pro

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115					120					125					
Lys	Ile	Lys	Asp	Val	Leu	Met	Ile	Ser	Leu	Ser	Pro	Ile	Val	Thr	Cys
130					135					140					
Val	Val	Val	Asp	Val	Ser	Glu	Asp	Asp	Pro	Asp	Val	Gln	Ile	Ser	Trp
145					150					155					160
Phe	Val	Asn	Asn	Val	Glu	Val	His	Thr	Ala	Gln	Thr	Gln	Thr	His	Arg
				165					170					175	
Glu	Asp	Tyr	Asn	Ser	Thr	Leu	Arg	Val	Val	Ser	Ala	Leu	Pro	Ile	Gln
			180					185					190		
His	Gln	Asp	Trp	Met	Ser	Gly	Lys	Glu	Phe	Lys	Cys	Lys	Val	Asn	Asn
		195					200					205			
Lys	Asp	Leu	Pro	Ala	Pro	Ile	Glu	Arg	Thr	Ile	Ser	Lys	Pro	Lys	Gly
	210					215					220				
Ser	Val	Arg	Ala	Pro	Gln	Val	Tyr	Val	Leu	Pro	Pro	Pro	Glu	Glu	Glu
225					230					235					240
Met	Thr	Lys	Lys	Gln	Val	Thr	Leu	Thr	Cys	Met	Val	Thr	Asp	Phe	Met
				245					250					255	
Pro	Glu	Asp	Ile	Tyr	Val	Glu	Trp	Thr	Asn	Asn	Gly	Lys	Thr	Glu	Leu
			260					265					270		
Asn	Tyr	Lys	Asn	Thr	Glu	Pro	Val	Leu	Asp	Ser	Asp	Gly	Ser	Tyr	Phe
		275					280					285			
Met	Tyr	Ser	Lys	Leu	Arg	Val	Glu	Lys	Lys	Asn	Trp	Val	Glu	Arg	Asn
	290					295					300				
Ser	Tyr	Ser	Cys	Ser	Val	Val	His	Glu	Gly	Leu	His	Asn	His	His	Thr
305					310					315					320
Thr	Lys	Ser	Phe	Ser	Arg	Thr	Pro	Gly	Lys						
				325					330						

<210> SEQ ID NO 8

<211> LENGTH: 20

<212> TYPE: PRT

<213> ORGANISM: Mus musculus

<400> SEQUENCE: 8

Met	Ser	Val	Pro	Thr	Gln	Val	Leu	Gly	Leu	Leu	Leu	Leu	Trp	Leu	Thr
1				5					10					15	

Asp	Ala	Arg	Cys
			20

<210> SEQ ID NO 9

<211> LENGTH: 107

<212> TYPE: PRT

<213> ORGANISM: Mus musculus

<400> SEQUENCE: 9

Asp	Ile	Gln	Met	Thr	Gln	Ser	Pro	Ala	Ser	Leu	Ser	Val	Ser	Val	Gly
1				5					10					15	

Glu	Thr	Val	Thr	Ile	Thr	Cys	Arg	Ala	Ser	Glu	Asn	Ile	Tyr	Ser	Asn
			20					25					30		

Leu	Ala	Trp	Tyr	Gln	Gln	Lys	Gln	Gly	Lys	Ser	Pro	Gln	Leu	Leu	Val
		35					40					45			

His	Ala	Ala	Thr	Asn	Leu	Ala	Asp	Gly	Val	Pro	Ser	Arg	Phe	Ser	Gly
	50					55				60					

Ser	Gly	Ser	Gly	Thr	Gln	Tyr	Ser	Leu	Lys	Ile	Asn	Ser	Leu	Gln	Ser
65					70					75				80	

Glu	Asp	Phe	Gly	Ser	Tyr	Tyr	Cys	Gln	His	Phe	Trp	Gly	Thr	Pro	Arg
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

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85	90	95
Thr Phe Gly Gly Gly Thr Lys Leu Glu Ile Lys		
100	105	

<210> SEQ ID NO 10
 <211> LENGTH: 107
 <212> TYPE: PRT
 <213> ORGANISM: Mus musculus
 <400> SEQUENCE: 10

Arg Ala Asp Ala Ala Pro Thr Val Ser Ile Phe Pro Pro Ser Ser Glu		
1	5	10 15

Gln Leu Thr Ser Gly Gly Ala Ser Val Val Cys Phe Leu Asn Asn Phe		
20	25	30

Tyr Pro Lys Asp Ile Asn Val Lys Trp Lys Ile Asp Gly Ser Glu Arg		
35	40	45

Gln Asn Gly Val Leu Asn Ser Trp Thr Asp Gln Asp Ser Lys Asp Ser		
50	55	60

Thr Tyr Ser Met Ser Ser Thr Leu Thr Leu Thr Lys Asp Glu Tyr Glu		
65	70	75 80

Arg His Asn Ser Tyr Thr Cys Glu Ala Thr His Lys Thr Ser Thr Ser		
85	90	95

Pro Ile Val Lys Ser Phe Asn Arg Asn Glu Cys		
100	105	

<210> SEQ ID NO 11
 <211> LENGTH: 8
 <212> TYPE: PRT
 <213> ORGANISM: Mus musculus

<400> SEQUENCE: 11

Gly Phe Thr Phe Ser Asp Ala Trp
1 5

<210> SEQ ID NO 12
 <211> LENGTH: 10
 <212> TYPE: PRT
 <213> ORGANISM: Mus musculus

<400> SEQUENCE: 12

Ile Arg Ser Lys Ala Asn Asn His Ala Thr
1 5 10

<210> SEQ ID NO 13
 <211> LENGTH: 9
 <212> TYPE: PRT
 <213> ORGANISM: Mus musculus

<400> SEQUENCE: 13

Thr Arg Val Lys Val Gly Phe Asp Asn
1 5

<210> SEQ ID NO 14
 <211> LENGTH: 6
 <212> TYPE: PRT
 <213> ORGANISM: Mus musculus

<400> SEQUENCE: 14

Glu Asn Ile Tyr Ser Asn
1 5

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<210> SEQ ID NO 15
<211> LENGTH: 3
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 15

Ala Ala Thr
1

<210> SEQ ID NO 16
<211> LENGTH: 9
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 16

Gln His Phe Trp Gly Thr Pro Arg Thr
1 5

<210> SEQ ID NO 17
<211> LENGTH: 5
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 17

Asp Ala Trp Met Asp
1 5

<210> SEQ ID NO 18
<211> LENGTH: 19
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 18

Glu Ile Arg Ser Lys Ala Asn Asn His Ala Thr Phe Tyr Ala Glu Ser
1 5 10 15

Val Lys Gly

<210> SEQ ID NO 19
<211> LENGTH: 7
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 19

Val Lys Val Gly Phe Asp Asn
1 5

<210> SEQ ID NO 20
<211> LENGTH: 11
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 20

Arg Ala Ser Glu Asn Ile Tyr Ser Asn Leu Ala
1 5 10

<210> SEQ ID NO 21
<211> LENGTH: 7
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 21

Ala Ala Thr Asn Leu Ala Asp
1 5

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<210> SEQ ID NO 22
<211> LENGTH: 9
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 22

Gln His Phe Trp Gly Thr Pro Arg Thr
1 5

<210> SEQ ID NO 23
<211> LENGTH: 7
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 23

Gly Phe Thr Phe Ser Asp Ala
1 5

<210> SEQ ID NO 24
<211> LENGTH: 8
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 24

Arg Ser Lys Ala Asn Asn His Ala
1 5

<210> SEQ ID NO 25
<211> LENGTH: 7
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 25

Val Lys Val Gly Phe Asp Asn
1 5

<210> SEQ ID NO 26
<211> LENGTH: 11
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 26

Arg Ala Ser Glu Asn Ile Tyr Ser Asn Leu Ala
1 5 10

<210> SEQ ID NO 27
<211> LENGTH: 7
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 27

Ala Ala Thr Asn Leu Ala Asp
1 5

<210> SEQ ID NO 28
<211> LENGTH: 9
<212> TYPE: PRT
<213> ORGANISM: Mus musculus

<400> SEQUENCE: 28

Gln His Phe Trp Gly Thr Pro Arg Thr
1 5

<210> SEQ ID NO 29
<211> LENGTH: 972

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<212> TYPE: PRT

<213> ORGANISM: Homo sapiens

<400> SEQUENCE: 29

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Met Gly Pro Gly Val Leu Leu Leu Leu Val Ala Thr Ala Trp His
 1          5          10          15

Gly Gln Gly Ile Pro Val Ile Glu Pro Ser Val Pro Glu Leu Val Val
 20          25          30

Lys Pro Gly Ala Thr Val Thr Leu Arg Cys Val Gly Asn Gly Ser Val
 35          40          45

Glu Trp Asp Gly Pro Pro Ser Pro His Trp Thr Leu Tyr Ser Asp Gly
 50          55          60

Ser Ser Ser Ile Leu Ser Thr Asn Asn Ala Thr Phe Gln Asn Thr Gly
 65          70          75          80

Thr Tyr Arg Cys Thr Glu Pro Gly Asp Pro Leu Gly Gly Ser Ala Ala
 85          90          95

Ile His Leu Tyr Val Lys Asp Pro Ala Arg Pro Trp Asn Val Leu Ala
100          105          110

Gln Glu Val Val Val Phe Glu Asp Gln Asp Ala Leu Leu Pro Cys Leu
115          120          125

Leu Thr Asp Pro Val Leu Glu Ala Gly Val Ser Leu Val Arg Val Arg
130          135          140

Gly Arg Pro Leu Met Arg His Thr Asn Tyr Ser Phe Ser Pro Trp His
145          150          155          160

Gly Phe Thr Ile His Arg Ala Lys Phe Ile Gln Ser Gln Asp Tyr Gln
165          170          175

Cys Ser Ala Leu Met Gly Gly Arg Lys Val Met Ser Ile Ser Ile Arg
180          185          190

Leu Lys Val Gln Lys Val Ile Pro Gly Pro Pro Ala Leu Thr Leu Val
195          200          205

Pro Ala Glu Leu Val Arg Ile Arg Gly Glu Ala Ala Gln Ile Val Cys
210          215          220

Ser Ala Ser Ser Val Asp Val Asn Phe Asp Val Phe Leu Gln His Asn
225          230          235          240

Asn Thr Lys Leu Ala Ile Pro Gln Gln Ser Asp Phe His Asn Asn Arg
245          250          255

Tyr Gln Lys Val Leu Thr Leu Asn Leu Asp Gln Val Asp Phe Gln His
260          265          270

Ala Gly Asn Tyr Ser Cys Val Ala Ser Asn Val Gln Gly Lys His Ser
275          280          285

Thr Ser Met Phe Phe Arg Val Val Glu Ser Ala Tyr Leu Asn Leu Ser
290          295          300

Ser Glu Gln Asn Leu Ile Gln Glu Val Thr Val Gly Glu Gly Leu Asn
305          310          315          320

Leu Lys Val Met Val Glu Ala Tyr Pro Gly Leu Gln Gly Phe Asn Trp
325          330          335

Thr Tyr Leu Gly Pro Phe Ser Asp His Gln Pro Glu Pro Lys Leu Ala
340          345          350

Asn Ala Thr Thr Lys Asp Thr Tyr Arg His Thr Phe Thr Leu Ser Leu
355          360          365

Pro Arg Leu Lys Pro Ser Glu Ala Gly Arg Tyr Ser Phe Leu Ala Arg
370          375          380

Asn Pro Gly Gly Trp Arg Ala Leu Thr Phe Glu Leu Thr Leu Arg Tyr
385          390          395          400

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Pro 405	Pro 420	Glu 435	Val 440	Ser 455	Val 470	Ile 485	Trp 490	Thr 410	Phe 425	Ile 445	Asn 460	Gly 475	Ser 495	Gly 415	Thr 430	Leu 445
Leu 465	Leu 480	Cys 495	Ala 510	Ala 525	Ser 540	Gly 555	Tyr 570	Pro 585	Gln 600	Pro 615	Asn 630	Val 645	Thr 660	Trp 675	Leu 690	Gln 705
Gln 720	Cys 735	Ser 750	Gly 765	His 780	Thr 795	Asp 810	Arg 825	Cys 840	Asp 855	Glu 870	Ala 885	Gln 900	Val 915	Leu 930	Gln 945	Val 960
Val 975	Trp 990	Asp 1005	Asp 1020	Pro 1035	Tyr 1050	Pro 1065	Glu 1080	Val 1095	Leu 1110	Ser 1125	Gln 1140	Glu 1155	Pro 1170	Phe 1185	His 1200	Val 1215
Lys 1230	Val 1245	Thr 1260	Val 1275	Gln 1290	Ser 1305	Leu 1320	Leu 1335	Thr 1350	Val 1365	Glu 1380	Thr 1395	Leu 1410	Glu 1425	His 1440	Asn 1455	Val 1470
Gln 1485	Thr 1500	Tyr 1515	Glu 1530	Cys 1545	Arg 1560	Ala 1575	His 1590	Asn 1605	Ser 1620	Val 1635	Gly 1650	Ser 1665	Gly 1680	Ser 1695	Trp 1710	Val 1725
Ala 1740	Phe 1755	Ile 1770	Pro 1785	Ile 1800	Ser 1815	Ala 1830	Gly 1845	Ala 1860	His 1875	Thr 1890	His 1905	Pro 1920	Pro 1935	Asp 1950	Glu 1965	Val 1980
Phe 2000	Leu 2015	Phe 2030	Thr 2045	Pro 2060	Val 2075	Val 2090	Val 2105	Ala 2120	Cys 2135	Met 2150	Ser 2165	Ile 2180	Met 2195	Ala 2210	Leu 2225	Val 2240
Leu 2255	Leu 2270	Leu 2285	Leu 2300	Leu 2315	Leu 2330	Leu 2345	Leu 2360	Tyr 2375	Lys 2390	Tyr 2405	Lys 2420	Lys 2435	Gln 2450	Lys 2465	Pro 2480	Val 2495
Lys 2510	Tyr 2525	Gln 2540	Val 2555	Arg 2570	Trp 2585	Lys 2600	Ile 2615	Ile 2630	Glu 2645	Ser 2660	Tyr 2675	Glu 2690	Gly 2705	Asn 2720	Ser 2735	Val 2750
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Phe 3020	Pro 3035	Arg 3050	Asn 3065	Asn 3080	Leu 3095	Gln 3110	Phe 3125	Gly 3140	Lys 3155	Thr 3170	Leu 3185	Gly 3200	Ala 3215	Gly 3230	Ala 3245	Val 3260
Phe 3275	Gly 3290	Lys 3305	Val 3320	Val 3335	Glu 3350	Ala 3365	Thr 3380	Ala 3395	Phe 3410	Gly 3425	Leu 3440	Gly 3455	Lys 3470	Glu 3485	Asp 3500	Val 3515
Ala 3530	Val 3545	Leu 3560	Lys 3575	Val 3590	Ala 3605	Val 3620	Lys 3635	Met 3650	Leu 3665	Lys 3680	Ser 3695	Thr 3710	Ala 3725	His 3740	Ala 3755	Val 3770
Asp 3785	Glu 3800	Lys 3815	Glu 3830	Ala 3845	Leu 3860	Met 3875	Ser 3890	Glu 3905	Leu 3920	Lys 3935	Ile 3950	Met 3965	Ser 3980	His 3995	Leu 4010	Val 4025
Gly 4040	Gln 4055	His 4070	Glu 4085	Asn 4100	Ile 4115	Val 4130	Asn 4145	Leu 4160	Leu 4175	Gly 4190	Ala 4205	Cys 4220	Thr 4235	His 4250	Gly 4265	Val 4280
Gly 4295	Pro 4310	Val 4325	Leu 4340	Val 4355	Ile 4370	Thr 4385	Glu 4400	Tyr 4415	Cys 4430	Cys 4445	Tyr 4460	Gly 4475	Asp 4490	Leu 4505	Leu 4520	Val 4535
Asn 4550	Phe 4565	Leu 4580	Arg 4595	Arg 4610	Lys 4625	Ala 4640	Glu 4655	Ala 4670	Met 4685	Leu 4700	Gly 4715	Pro 4730	Ser 4745	Leu 4760	Ser 4775	Val 4790
Pro 4800	Gly 4815	Gln 4830	Asp 4845	Pro 4860	Glu 4875	Gly 4890	Gly 4905	Val 4920	Asp 4935	Tyr 4950	Lys 4965	Asn 4980	Ile 4995	His 5010	Leu 5025	Val 5040
Glu 5050	Lys 5065	Lys 5080	Tyr 5095	Val 5110	Arg 5125	Arg 5140	Asp 5155	Ser 5170	Gly 5185	Phe 5200	Ser 5215	Ser 5230	Gln 5245	Gly 5260	Val 5275	Val 5290
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Phe 5550	Ser 5565	Glu 5580	Gln 5595													

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Leu Pro Val Lys Trp Met Ala Pro Glu Ser Ile Phe Asp Cys Val Tyr
 820 825 830
 Thr Val Gln Ser Asp Val Trp Ser Tyr Gly Ile Leu Leu Trp Glu Ile
 835 840 845
 Phe Ser Leu Gly Leu Asn Pro Tyr Pro Gly Ile Leu Val Asn Ser Lys
 850 855 860
 Phe Tyr Lys Leu Val Lys Asp Gly Tyr Gln Met Ala Gln Pro Ala Phe
 865 870 875 880
 Ala Pro Lys Asn Ile Tyr Ser Ile Met Gln Ala Cys Trp Ala Leu Glu
 885 890 895
 Pro Thr His Arg Pro Thr Phe Gln Gln Ile Cys Ser Phe Leu Gln Glu
 900 905 910
 Gln Ala Gln Glu Asp Arg Arg Glu Arg Asp Tyr Thr Asn Leu Pro Ser
 915 920 925
 Ser Ser Arg Ser Gly Gly Ser Gly Ser Ser Ser Ser Glu Leu Glu Glu
 930 935 940
 Glu Ser Ser Ser Glu His Leu Thr Cys Cys Glu Gln Gly Asp Ile Ala
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 <220> FEATURE:
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<400> SEQUENCE: 33

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atcacctgca gggccagcga gaacatctac agcaacctgg cctggatatca gcagaagcag	180
ggcaagagcc ccagctgct ggtgcacgct gccaccaacc tggccgacgg cgtgccctcc	240
aggttcagcg gcagcggctc cggcacccag tacagcctga agatcaacag cctgcagagc	300
gaggacttcg gcagctacta ctgccagcac ttctggggca cccaaggac ctteggcggc	360
ggcaccaagc tggagatcaa gaggaccgtg gccgccccca gcgtgttcat cttccccccc	420
agcgacgagc agctgaagag cggcaccgcc tccgtggtgt gcctgctgaa caactctac	480
ccccgggagg ccaaggtgca gtggaagggt gacaacgccc tgcagagcgg caacagccag	540
gaaagcgtca ccgagcagga cagcaaggac tccacctaca gcctgagcag caccctgacc	600
ctgagcaagg ccgactacga gaagcacaag gtgtacgcct gcgaggtgac ccaccagggc	660
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<213> ORGANISM: Artificial Sequence

<220> FEATURE:

<223> OTHER INFORMATION: Description of Artificial Sequence: plasmid
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tgcgcccga cggccttcac ctccagcgac gcctggatgg actgggtgcg ccagagcccc	180
gagatggggc tggagtgggt ggccgagatc aggtccaagg ccaacaacca cgccaccttc	240
tacgccgaga gcgtgaaggg caggttcacc atcagcaggg acgacagcaa gagcagcgtg	300
tacctgcaga tgaacagcct gaggcccgag gacaccggca tctactactg caccagagtg	360
aaagtgggct tcgacaactg gggccagggc accacactga ccgtgtccag cgccagcacc	420
aaggggccca gcgtgttccc cctggccccc agctccaaga gcaccagcgg aggaacagct	480
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agcctgagca gcgtgggtgac agtgcccagc agcagcctgg gcacccagac ctacatctgc	660
aacgtgaacc acaagcccag caacaccaag gtggacaaga aggtggagcc caagagctgc	720
gacaagacct acacctgtcc tccctgcccga ccccagagc tgctgggcgg accctccgtg	780
ttcctgttcc ccccaagcc caaggacacc ctgatgatca gcaggacccc cgaggtgacc	840
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ggcgtggagg tgcacaacgc caagaccaag cccagagagg aacagtacaa cagcacctac	960
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ggccagccac gggagcccca ggtgtacacc ctgccccct cccgggacga gctgaccaag	1140
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tgggagagca acgcccagcc cgagaacaac tacaagacca cccccccagt gctggacagc	1260
gacggcagct tcttcctgta cagcaagctg accgtggaca agagcagggtg gcagcagggc	1320
aacgtgttca gctgcagcgt gatgcacgag gccctgcaca accactacac ccagaagagc	1380
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tgcgtgcca gcggttcac ctccagcgac gcctggatgg actgggtg cgagagcccc	180
gagatgggcc tggagtgggt ggccgagatc aggtccaagg ccaacaacca cgccaccttc	240
tacgcccaga gcgtgaaggg caggttcacc atcagcaggg acgacagcaa gagcagcgtg	300
tacctgcaga tgaacagcct gagggccgag gacacggca tctactactg caccagagtg	360
aagggtgggt tgcacaactg gggccagggc accacactga ccgtgtccag cgccagcacc	420
aaggggccaa gcgtgttccc cctggcccc tgcagcagaa gcaccagcga gagcacagcc	480
gccctgggct gcctggtgaa ggactacttc cccgagcccg tgaccgtgtc ttggaacagc	540
ggagccctga ccagcggcgt gcacaccttc cccgcccgtg tgcagagcag cgccctgtac	600
agcctgagca gcgtggtgac cgtgcccagc agcagcctgg gcaccaagac ctacacctgc	660
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ccccccaagc ccaaggacac cctgatgac agcaggaccc ccgaggtgac ctgcgtggtg	840
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gtgcacaacg ccaagacca gcccagagag gaacagtta acagcaccta cagggtggtg	960
tccgtgctga ccgtgctgca ccaggactgg ctgaacggca aggaatacaa gtgcaaggtc	1020
tccaacaagg gcctgcccag ctccatcgaa aagaccatca gcaaggccaa gggccagcca	1080
cgggagcccc aggtgtacac cctgccaccc agccaaggag aaatgaccaa gaaccagggtg	1140
tccctgacct gtctggtgaa gggcttctac cccagcgaca tcgcccgtga gtgggagagc	1200
aacggccagc ccgagaacaa ctacaagacc cccccccag tgctggacag cgacggcagc	1260
ttcttctctg acagcaggct gaccgtggac aagtcagggt ggcaggaagg caacgtcttt	1320
agctgcagcg tgatgcacga ggccctgcac aaccactaca cccagaagag cctgagcctg	1380
tccctgggca agtga	1395

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The invention claimed is:

1. An isolated nucleic acid encoding an antibody that specifically binds to human CSF-1R, the antibody comprising a heavy chain variable region comprising

(a) a CDR1 comprising the amino acid sequence starting at position 45 and finishing at position 54 of SEQ ID NO:2,

(b) a CDR2 comprising the amino acid sequence starting at position 66 and finishing at position 87 of SEQ ID NO:2, and

(c) a CDR3 comprising the amino acid sequence starting at position 117 and finishing at position 126 of SEQ ID NO:2; and

a light chain variable region comprising

(a) a CDR1 comprising the amino acid sequence starting at position 44 and finishing at position 56 of SEQ ID NO:4,

(b) a CDR2 comprising the amino acid sequence starting at position 66 and finishing at position 76 of SEQ ID NO:4, and

(c) a CDR3 comprising the amino acid sequence starting at position 109 and finishing at position 117 of SEQ ID NO:4.

2. The isolated nucleic acid of claim 1, wherein the heavy chain variable region of the antibody comprises the amino acid sequence as set forth in SEQ ID NO:6.

3. The isolated nucleic acid of claim 2, wherein the heavy chain variable region of the antibody consists of SEQ ID NO:6.

4. The isolated nucleic acid of claim 1, wherein the light chain variable region of the antibody comprises the amino acid sequence as set forth in SEQ ID NO:9.

5. The isolated nucleic acid of claim 4, wherein the light chain variable region of the antibody consists of SEQ ID NO:9.

6. The isolated nucleic acid of claim 2, wherein the light chain variable region of the antibody comprises the amino acid sequence as set forth in SEQ ID NO:9.

7. The isolated nucleic acid of claim 2, wherein the encoded antibody is a chimeric antibody.

8. The isolated nucleic acid of claim 7, wherein the light chain variable region of the antibody comprises the amino acid sequence as set forth in SEQ ID NO:9.

9. The isolated nucleic acid of claim 1, wherein the heavy chain variable region of the antibody comprises the amino acid sequence as set forth in SEQ ID NO:6 modified by the amino acid substitutions K3Q, E5V, M18L, and P90A and wherein the light chain variable region of the antibody comprises the amino acid sequence as set forth in SEQ ID NO:9.

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10. The isolated nucleic acid of claim 1, wherein the heavy chain variable region of the antibody comprises the amino acid sequence as set forth in SEQ ID NO: 6 modified by the amino acid substitutions K3Q, E5V, M18L, K19R, S40A, E42G, M43K R89K, P90T, I95V, T113L, and L114V, and wherein the light chain variable region of the antibody comprises the amino acid sequence as set forth in SEQ ID NO:9.

11. An isolated nucleic acid of encoding an antibody that specifically binds to human CSF-1R, the antibody comprising:

a heavy chain variable region comprising the amino acid sequence as set forth in SEQ ID NO:6, and

a light chain variable region comprising the amino acid sequence as set forth in SEQ ID NO:9 modified by the amino acid substitutions A9S, E17D, T18R, Q40P, S43A, Q45K, A55E, D56S, Q70D, S72T, K74T, N76S, S80P, S85T, and G100Q.

12. An isolated nucleic acid encoding an antibody that specifically binds to human CSF-1R, the antibody comprising:

a heavy chain variable region comprising the amino acid sequence as set forth in SEQ ID NO:6, and

a light chain variable region comprising the amino acid sequence as set forth in SEQ ID NO:9 modified by the amino acid substitutions A9S, V13A, E17D, T18R, Q40D, K74T, N76S, and S80P.

13. An isolated nucleic acid encoding an antibody that specifically binds to human CSF-1R, comprising:

a heavy chain variable region comprising the amino acid sequence as set forth in SEQ ID NO:6, and

a light chain variable region comprising the amino acid sequence as set forth in SEQ ID NO:9 modified by the amino acid substitutions A9S, V13A, E17D, T18R, Q40P, S43A, Q45K, V48L, D56S, Q70D, S72T, K74T, N76S, S80P, G84A, S85T, and G100Q.

14. The isolated nucleic acid of claim 1, wherein the antibody is a polyclonal antibody, monoclonal antibody, Fab, F(ab')₂, Fv, scFv, antigen binding fragment, or diabody.

15. The isolated nucleic acid of claim 14, wherein the antibody is a monoclonal antibody.

16. The isolated nucleic acid of claim 1, wherein the antibody has a binding affinity for human CSF-1R of at least 10⁹ M⁻¹.

17. A vector comprising the nucleic acid of claim 1.

18. A kit comprising the vector of claim 17.

19. A composition comprising the vector of claim 17 and a pharmaceutically acceptable carrier.

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